TM 5-666

WAR DEPARTMENT TECHNICAL MANUAL

INSPECTIONS and PREVENTIVE MAINTENANCE SERVICES

SEWAGE TREATMENT PLANTS and SEWER SYSTEMS at FIXED INSTALLATIONS

WAR DEPARTMENT • SEPTEMBER 1945

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United States Government Printing Office
Washington : 1945

WAR DEPARTMENT

WASHINGTON 25, D. C., 29 September 1945

TM 5–666, Inspections and Preventive Maintenance Services, Sewage Treatment Plants and Sewer Systems at Fixed Installations, is published for the information and guidance of all concerned.

[AG 300.7 (11 June 45)]

BY ORDER OF THE SECRETARY OF WAR:

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Chief of Staff

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ASF (2); Tech Sv (2) except OCE (150); S Div ASF (1); Sv C (10); Air Tech SvC (10); FC (5); Class III Instls (5); Dist 5 (2); Div Eng (10); 1st, 2nd, 3rd, 4th AF (10). No oversea distribution. Refer to FM 21–6 for explanation of distribution formula.

ACKNOWLEDGEMENT

The courtesy of the Federation of Sewage Works Associations and the publishers of Public Works, Sewage Works Engineering and Water Works and Sewerage in permitting free use of the material contained in their publications is hereby acknowledged.

Contents

SECTION I

GENERAL

1. Purpose and Scope

This Technical Manual covers preventive maintenance services to be performed at all Army sewage treatment plants, pumping stations, and sewer systems at fixed installations. It is written as part of the Army's preventive maintenance program to help operating personnel keep equipment in satisfactory operating condition and to guide them in systematically detecting and correcting incipient failures before they occur or develop into major defects.

The manual includes instructions on inspecting, cleaning, servicing, lubricating, and adjusting equipment, and a full explanation of how to keep proper maintenance records. Instructions are based on recommendations of experienced engineers and operators and on advice from equipment manufacturers.

Since much of the equipment in a post sewage plant is practically tailor-made to fit conditions at that post, preventive maintenance discussed in this text may occasionally require modification or revision. Even on mass-production equipment, differences in installation and service conditions at different posts may make modifications in the preventive maintenance program necessary. Therefore, a survey of plant property, operators' experiences, and manufacturer's instructions must be made at each post to prepare necessary changes to the suggested schedule of preventive maintenance operations.

For maintenance of equipment not specifically mentioned or not fully discussed, consult the post engineer and manufacturers' instructions on maintaining similar equipment.

2. Organization of Manual

To make it easier for maintenance personnel to use this manual, it is divided into sections, each covering maintenance of a particular type of equipment. In addition the following reference guides are used:

a. ITEM NUMBERS. (1) An item number is assigned each operation in the inspection and service procedure for a unit. (See numbers in time columns of par. 14.) This simplifies preparation of work schedules and maintenance forms (par. 4), since required maintenance can be shown by listing appropriate item numbers on the work schedule and service record. Maintenance personnel can then determine their specific duties by referring to the schedule for item numbers and to the manual for the discussion under those item numbers.

(2) When the maintenance procedure for a unit includes a reference to another part of the manual, the cross-referenced operation is identified by a dagger (†) instead of an item number. This symbol is *not* to be used on maintenance records; the appropriate item numbers are to be taken from the paragraph or section given as the cross-reference.

(3) Since it was not feasible to use a consecutive numbering system throughout the manual in assigning item numbers, the same series of item numbers is used occasionally to identify maintenance procedures for different units. In those cases, the type equipment involved will indicate the proper reference and prevent misunderstanding.

b. TIME-SCHEDULE COLUMNS. Time-schedule columns printed in the left-hand margins (par. 14) help in scheduling maintenance operations.

(1) Location of an item number in one of the columns shows the minimum frequency with which that operation must be performed.

(2) An asterisk (*) in the *annual* column indicates varying maintenance frequency, depending on nature of the installation and conditions of use. In such instances, each post determines suitable frequencies on the basis of manufacturer's recommendations and its own experience with the equipment.

(3) Total maintenance required on a unit during a particular period can be determined quickly by checking the appropriate time-sched-

ule column and noting the total of item numbers listed.

3. Equipment Classification

a. CLASSIFICATION CODE. Setting up an equipment classification code helps identify equipment in the system and simplifies record keeping. The decimal coding method is suggested. In this method, *S* represents sewage equipment, the *digit* stands for class of equipment, and the *decimal* differentiates between types of equipment in each class. The following is a typical classification code:

S 1.0 Pumps and appurtenances.
S 1.1 Raw sewage pumps.
S 1.2 Recirculating pumps.
S 1.3 Sludge pumps.
S 1.4 Sump pumps.
S 2.0 Screens, comminutors, and appurtenances.
S 2.1 Hand-raked coarse-bar screen.
S 2.2 Mechanically cleaned bar screens.
S 2.3 Triturators.
S 2.4 Comminutors.
S 3.0 Grit chambers and appurtenances.
S 4.0 Sedimentation-tank equipment.
S 5.0 Trickling-filter equipment.
S 6.0 Dosing-siphon equipment.
S 7.0 Aeration tanks and appurtenances.
S 8.0 Intermittent sand filters.
S 9.0 Digestion-tank equipment.
S 10.0 Boiler, gas burners, and appurtenances.
S 11.0 Sludge-cake shredders.
S 12.0 Meters.
S 13.0 Chlorinators.
S 14.0 Variable-speed drives.
S 15.0 Sewer system.

b. EQUIPMENT NUMBERING. To insure proper identification and correct records, each post engineer must assign an identification number to each major piece of equipment or accessory in the sewer system, sewage pumping stations, and sewage treatment plant. There is no set numbering method. A hyphenated system is recommended: the first part would show building or functional structure number, taken from the real property card; next would be the equipment classification code; the last figure in the series would distinguish between a number of identical units located in the same building, and is necessary only when a building contains more than one unit of a particular type. In this method, identifying number T672–S 5.11–3 would represent filter distributor No 3 in building T672.

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UTILITIES INSPECTION AND SERVICE RECORD

EQUIP. No. | DESCRIPTION

PREVENTIVE MAINTENANCE TO BE DONE BY:

ITEM No.	WORK TO BE DONE	REFERENCE	FREQUENCY	TIME

Schedule Inspection and Service on this side.
Record Inspection and Service on reverse side.

16—43408-1

1

SERVICE RECORD

DATE	WORK DONE	SIGNED	DATE	WORK DONE	SIGNED	DATE	WORK DONE	SIGNED

U. S. GOVERNMENT PRINTING OFFICE 16—43409-1

2

Figure 1. Post sewage plant utilities inspection and service record card.

SECTION II

RECORD KEEPING

4. Utilities Inspection and Service Record

Preventive maintenance programs are effective only if careful, accurate, and complete records are kept of all work done. In no other way can the post engineer insure that all personnel are carrying out their individual responsibilities and that all equipment is being properly maintained. In post sewage plants, WD AGO Form 5–34, Utilities Inspection and Service Record (fig. 1), is used as the work sheet and record card of inspections and services performed.

a. WHEN USED. Forms are prepared by the sanitary engineer or works supervisor after a study of the maintenance needed for each piece of equipment; assistance of the plant foreman and operators may be enlisted.

(1) Separate forms are made out for each major separate piece of equipment, including accessories needed to operate it. Thus, the card for a sewage pump includes pump, motor, and float control. A gasoline-engine primary on stand-by drive or a control are carried on separate cards. (See also par. 15*g*.)

(2) If inspection and service operations on a unit include more than 20 steps (*b*(4) below), a separate card is prepared for 1 or more components of the unit. The notation *continued on next card* is entered on the bottom line of the first card.

(3) Each long independent force main should be carried on a separate card.

(4) The gravity sewer system should be divided into areas or blocks and a card prepared for each area, listing all manholes, sewers, and appurtenances (except pumping stations) flowing to a pumping station or having an individual outlet.

b. FILLING IN THE FORM. Procedure for making out a record card is discussed below. For an example of a completed card, see figure 2.

(1) *Equipment number.* Insert identification number (par. 3*b*).

(2) *Description.* Describe equipment briefly but in enough detail so it can be identified readily.

(3) *Preventive maintenance to be done by.* Show job title and name of person responsible for maintenance; this should be the person who actually operates the equipment. He is also responsible for reminding the chief operator, superintendent, or other supervisor of any special semiannual or annual inspections they are to make, and for insuring that the supervisor makes an appropriate entry on the record card after inspection is completed.

(4) *Work to be done.* Study manual and note all inspection and service required. Enter in this space the paragraph or subparagraph heading describing the operation. Add any operations not covered in manual but needed to maintain a particular unit. *Make sure all necessary inspections and services are shown on record card.* List operations in order of frequency of performances with daily service first.

(5) *Item number.* Identify each operation with proper item number. Where the same item number is used to identify different operations, differentiate between them by adding a letter to one of the numbers; thus, if 1 is used twice, write one of them as 1*a*.

(6) *Reference.* Insert paragraph numbers to facilitate reference to manual.

(7) *Frequency.* Record frequency of operations, as shown in time-schedule columns. Modify suggested frequencies to fit local conditions.

(8) *Time.* Show specific day or month service is due (see fig. 2(1)). Stagger quarterly, semiannual, and annual inspections to prevent rush periods and conflicts in schedule. Choose season when work can be done best.

(9) *Tab index.* Mark an X at top of form alongside each month during which work is to be done or report submitted. This helps sched-

ule operations, since over-all work in the plant in a given month can be quickly determined by reference to the tab index.

(10) *Service record* (fig. 2(2)). On back of card, record date and item number whenever maintenance is performed, and initial. If service needed is beyond the ability or authority of the inspector, he requests skilled help and enters the request in the *work done* column. For example, if inspection of a motor reveals a grooved commutator, the entry would read "Electrician needed to complete item 51—commutator grooved." The work order number is entered alongside under column headed *signed*, and is initialed.

When all spaces on the service record are filled in, staple a blank card to the original.

5. Record-Card System

The record-card system consists of duplicate sets of WD AGO Form 5–34, one set making up a *field file* and the other a *master file*.

a. FIELD FILE. The field file is made up of the forms forwarded to inspectors who maintain the equipment. The inspector is also given a manual so he can study it and become familiar with his specific duties. Inspectors make all service entries and keep their copies of the forms up-to-date. Forms are in the inspectors' possession except at the beginning of the month, when they are sent to the supervisor for transfer of consolidated data to the master file.

b. MASTER FILE. Record cards in the master file (fig. 2(3) and (4)) are arranged by equipment number and kept in the work supervisor's office. A movable tab is placed on the tab index of each card, above the month during which maintenance for the unit is next scheduled. When inspectors turn in the field file at the beginning of the month, entries are checked to insure that all work was done and a summary of the entries is transferred to the master file. The summary includes any special difficulties encountered by the inspector, work orders required for maintenance, and a consolidated entry of items checked. For a typical master-file entry, see figure 2(4), based on the field-file card in figure 2(2). After all entries are made, movable tabs are then shifted to the next month when maintenance is scheduled and field-file cards are returned to inspectors. Any tabs in the master file that are not moved are readily apparent. Since they indicate that a field-file card was not turned in or that work was not completed, immediate follow-up is essential.

JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
X	X	X	X	X	X	X	X	X	X	X	X

WD AGO FORM 1 JAN 1945 5-34

UTILITIES INSPECTION AND SERVICE RECORD

EQUIP. No. T 672-55.11-1 | DESCRIPTION NE FILTER DISTRIBUTOR, AMER WELL, MOTOR-DRIVEN

PREVENTIVE MAINTENANCE TO BE DONE BY: SEWAGE PLANT DAY-SHIFT OPERATOR, JOHN DOE

ITEM No.	WORK TO BE DONE	REFERENCE	FREQUENCY	TIME
1	CLEAN JETS	63 a	DAILY	
2	FLUSH ARMS	63 b	"	
4	CHECK AIR-RELIEF PIPE	64 b	"	
50, 51	CHECK MOTOR CONDITION	14 a & b	"	
5	LUBRICATE OIL SEAL AND GUIDE BEARING	64 c	WEEKLY	MONDAY
1a	CHECK OIL LEVEL IN REDUCER	58 a	"	"
6	LUBRICATE MAIN THRUST BEARING	64 e	MONTHLY	1ST MONDAY
7	CHECK FOR EXTREME SURGES	64 h	"	"
2a, 3a	CHECK TENSION AND ALIGNMENT (V-BELT DRIVE)	16 b	"	"
53	CHECK GREASE IN MOTOR BALL BEARINGS	14c (2)	"	"
8	CHECK FREEZEOUT PLUG	64 f	QUARTERLY	NOV, FEB
				MAY, AUG
3	ADJUST ARMS	63 c	SEMIANNUALLY	MAY, NOV
5a	CHANGE OIL IN REDUCER	58 a	"	" "
11	CHECK BRUSHES AND CLEAN COLLECTOR RINGS	64 i	"	" "
12	CHECK COUPLING ALIGNMENT	19 b	"	" "
54	FLUSH ANTIFRICTION BEARINGS	14 d	"	" "

Schedule Inspection and Service on this side.
Record Inspection and Service on reverse side.

16—43498-1

(1)

SERVICE RECORD

DATE	WORK DONE	SIGNED	DATE	WORK DONE	SIGNED	DATE	WORK DONE	SIGNED
1/8/45	1, 2, 4, 50, 51, OK	J.D.	1/25	1, 2, 4, 50, 51, OK	J.D.	2/14	1, 2, 4, 50, 51, OK	J.D.
1/9/45	"	J.D.	1/26	"	J.D.	2/15	"	J.D.
1/10	"	J.D.	1/27	1, 2, 4, 50, 51 OK	J.D.	2/16	"	J.D.
1/11	"	J.D.	1/28	"	C.E.	2/17	"	J.D.
1/12	"	J.D.	1/29	5, 1a DONE	J.D.	2/18	"	C.E.
1/13	"	J.D.	"	1, 2, 4, 50, 51 OK	J.D.	2/19	1, 2, 4, 50, 51, OK	J.D.
1/14	"	C.E.	1/30	"	J.D.	"	5, 1a (ADDED OIL)	J.D.
1/15	1, 2, 4, 50, 51 OK	J.D.	1/31	"	J.D.	2/20	1, 2, 4, 50, 51 OK	J.D.
"	5, 1a DONE	J.D.	2/1	"	J.D.	2/21	"	J.D.
1/16	1, 2, 4, 50, 51, OK	J.D.	2/2	"	J.D.	2/22	"	J.D.
1/17	"	J.D.	2/3	"	J.D.	2/23	"	J.D.
1/18	"	J.D.	2/4	"	C.E.	2/24	"	J.D.
1/19	"	J.D.	2/5	5, 1a, 6, 7, 2a, 3a 53		2/25	1, 2, 4, 50, 51 OK	C.E.
1/20	"	J.D.		1, 2, 4, 50, 51 OK	J.D.	2/26	1, 2, 4, 50, 51, 5, 1a OK	J.D.
1/21	"	C.E.	2/6	"	J.D.	2/27	1, 2, 4, 50, 51 OK	J.D.
1/22	51, VIBRATION RPTD		2/7	"	J.D.	2/28	"	J.D.
	TO POST ENGR	J.D.	2/8	1, 2, OK 4 CLOGGED		3/1	"	J.D.
"	1, 2, 4, 50 OK	J.D.		50, 51 OK	J.D.	3/2	"	J.D.
"	5, 1a DONE	J.D.	2/9	1, 2, 4, 50, 51 OK	J.D.	3/3	"	J.D.
1/23	1, 2, 4, 50 OK	J.D.	2/10	"	J.D.	3/4	1, 2, 4, 50, 51 OK	C.E.
1/24	ABOVE OK. ELECT		2/11	"	C.E.	3/5	1, 2, 4, 50, 51, 5, 1a OK	J.D.
	REPAIRED MOTOR	J.D.	2/12	1, 2, 4, 50, 51, 5, 1a OK	J.D.	"	6, 7, 2a, 3a, 53 OK	J.D.
	W O 220	G.B.S.	2/13	1, 2, 4, 50, 51 OK	J.D.	3/6	SEE STAPLED CARD	J.D.

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(2)

Figure 2. Typical filled-in utilities inspection and record card.

JAN.	FEB.	MAR	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
X	X	X	X	X	X	X	X	X	X	X	X

WD AGO FORM 1 JAN 1945 5-34

UTILITIES INSPECTION AND SERVICE RECORD

EQUIP. No. T672-55.11-1 | DESCRIPTION NE FILTER DISTRIBUTOR, AMER WELL, MOTOR-DRIVEN

PREVENTIVE MAINTENANCE TO BE DONE BY: SEWAGE PLANT DAY-SHIFT OPERATOR, JOHN DOE

ITEM No.	WORK TO BE DONE	REFERENCE	FREQUENCY	TIME
1	CLEAN JETS	63a	DAILY	
2	FLUSH ARMS	63b	"	
4	CHECK AIR-RELIEF PIPE	64b	"	
50, 51	CHECK MOTOR CONDITION	14a&b	"	
5	LUBRICATE OIL SEAL AND GUIDE BEARING	64c	WEEKLY	MONDAY
1a	CHECK OIL LEVEL IN REDUCER	58a	"	"
6	LUBRICATE MAIN THRUST BEARING	64e	MONTHLY	1ST MONDAY
7	CHECK FOR EXTREME SURGES	64h	"	"
2a, 3a	CHECK TENSION AND ALIGNMENT (V-BELT DRIVE)	16b	"	"
53	CHECK GREASE IN MOTOR BALL BEARINGS	14c (2)	"	"
8	CHECK FREEZEOUT PLUG	64f	QUARTERLY	NOV, FEB
				MAY, AUG
3	ADJUST ARMS	63c	SEMIANNUALLY	MAY, NOV
5a	CHANGE OIL IN REDUCER	58a	"	"
11	CHECK BRUSHES AND CLEAN COLLECTOR RINGS	64i	"	"
12	CHECK COUPLING ALIGNMENT	19b	"	"
54	FLUSH ANTIFRICTION BEARINGS	14d	"	"

Schedule Inspection and Service on this side.
Record Inspection and Service on reverse side.

16—43488-1

3

SERVICE RECORD

DATE	WORK DONE	SIGNED	DATE	WORK DONE	SIGNED	DATE	WORK DONE	SIGNED
1/24	ELEC MOTOR REPAIRED							
	WO 220	J.M.						
JAN	1, 2, 4, 50, 51 OK	J.M.						
"	5, 1a OK	J.M.						
2/8	4 CLOGGED	J.M.						
FEB	1, 2, 4, 50, 51 OK	J.M.						
"	5, 1a OK	J.M.						
2/19	5, 1a ADDED OIL	J.M.						

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Figure 2. Typical filled-in utilities inspection and record card—Continued.

SECTION III

GENERAL PREVENTIVE MAINTENANCE SERVICES

6. Tools

An adequate supply of the tools needed to service the specialized equipment in post sewage plants is essential to efficient conduct of the preventive maintenance program.

a. TOOLS NEEDED. (1) The number and type of tools needed varies, depending on the degree of mechanization of the plant. To determine the kind and number of tools required, review all record cards and note the tools needed for the operations listed. Include a work bench and vise for operators.

(2) The lists below are *minimum* requirements; they are given to illustrate preparation of tool lists.

(*a*) *For pumps.* Socket wrench sets: 7/16- to 1 1/8-inch sizes, inclusive.
Pliers, two pair: one slip joint; one side cutting.
Screw drivers, set of three: 3-, 4-, and 6-inch blades.
Stillson wrenches, two: one 10 inch, and one 18 inch.
Hammer, machinist's, 2-pound.
Oil cans, three or four spout oilers with contents plainly marked.
Putty knife, for scraping old gaskets from pump casings.
Thickness gauge, for spacing and setting couplings and checking clearances of pump rings.
Packing tools, full set, for removing and replacing packing in stuffing boxes.
Spirit level (machinist's level of dependable make).
Special pump tools.

(*b*) *For sewer cleaning.* Set of steel rods with reel and hand ratchet.
Corkscrew tools, for 2-, 6-, 8-, 10- and 12-inch sizes.
Augers, for 4- and 6-inch sizes.
Sand cups, sizes as needed.
Hand winch.
Cable and bucket.
Turbine cleaner with cutting knives.
Fire hose, 2½-inch (used).
Pneumatic balls, sizes as needed.
Portable trench pump.

b. TOOL BOARDS. There is no set method of keeping tools convenient for use. However, use of tool boards insures their ready accessibility; painting the outline of each tool in its proper place on the board simplifies replacement and reduces loss.

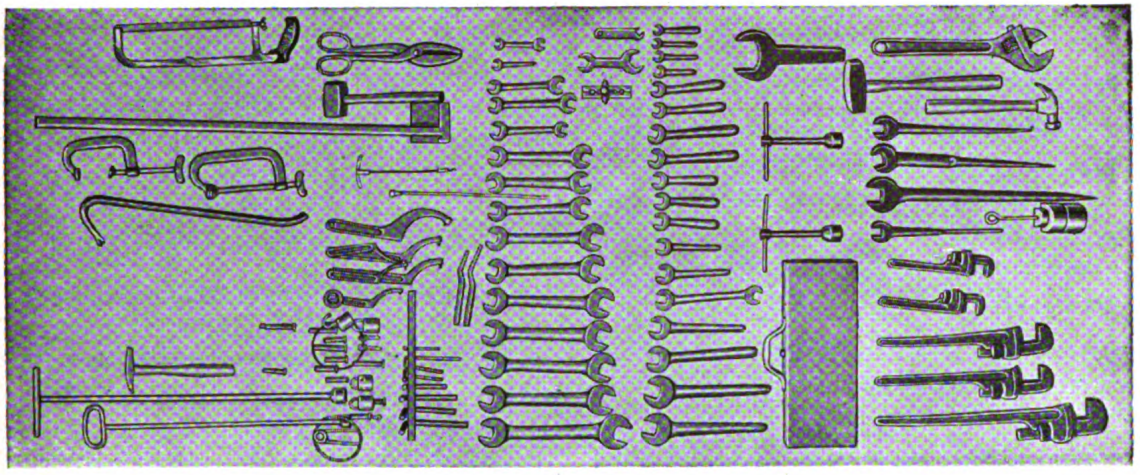
c. SAFETY EQUIPMENT. Appropriate safety equipment should be obtained and should be available at all times. Such equipment includes safety harnesses, ropes, ladders, gas masks, protective clothing, safety lamps, toxic-gas and oxygen-deficiency indicators, and explosimeters. Safety equipment must be used on any hazardous maintenance operation. Presence and extent of toxic gases and degree of oxygen deficiency must be determined before personnel are allowed to enter inclosed tanks and chambers.

7. Lubrication

The variety of types of equipment and conditions under which they operate make proper lubrication practices extremely important. Improper lubrication causes damage to wearing surfaces, increased maintenance costs and power consumption, and outages.

a. USE. War Department Lubrication Orders and Lubrication Charts prescribe the lubricating oils, greases, preservatives, and corrosion preventives used to lubricate and preserve all sewage treatment plant equipment. These products are listed in tables I through V below, to help the post engineer in procurement. The post engineer and his staff must familiarize themselves with these tables to insure proper use of lubricants and preservatives and compliance with lubrication instructions given in other sections of this manual. Questions on use of products listed or on substitutes for them

must be referred to the Office, Chief of Engineers. When a War Department Lubrication Order is published on any piece of equipment, lubrication prescriptions in it are mandatory and supersede any conflicting instructions given in this manual.



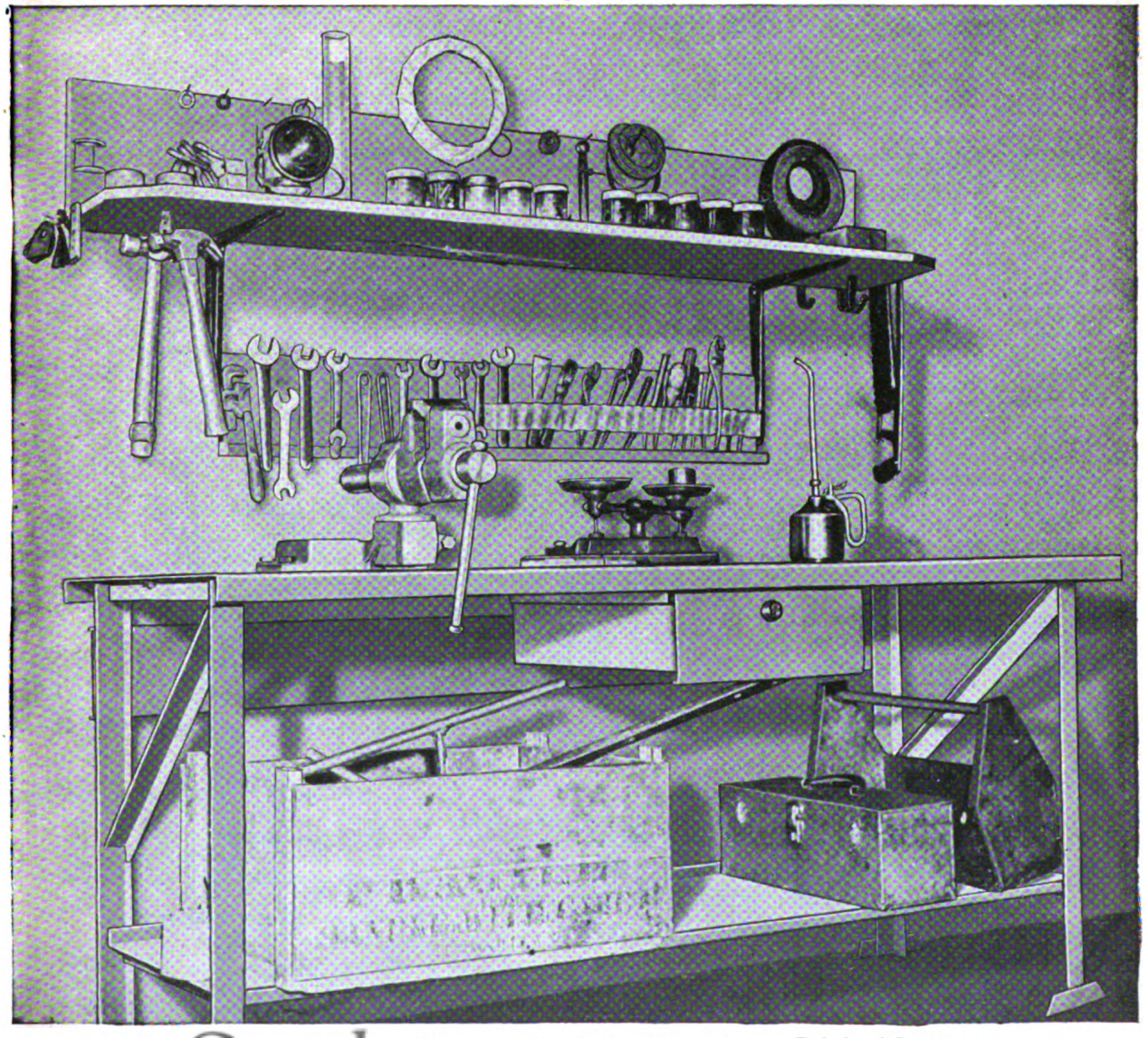


Figure 3. Typical tool boards.

b. SUBSTITUTING LUBRICANTS. Lubrication instructions given in this manual include recommended types and intervals. However, these are only guides and may require modification depending on the use of equipment and severity of operating conditions.

c. PRECAUTIONS. (1) Never overlubricate. Too much lubricant causes antifriction bearings to heat up and may damage grease seals. In motors, overlubrication may damage windings. Ninety percent of Army plant motor failures are caused by overlubrication.

(2) Do not lubricate incompletely inclosed or inadequately guarded machinery while it is in motion.

(3) Guard against dust, grit, and abrasives getting into containers used for storing lubricants. Store oils and greases in a dust-free location and keep containers covered at all times. Wipe spouts and lips clean before using container; clean grease guns and fittings before applying grease.

d. GREASE FITTINGS. Lubrication is simplified, number of grease guns required is reduced, and use of wrong lubricants prevented if all lubrication points requiring the same grease are fitted with the same type grease-gun fitting. Each gun can then be plainly marked with the kind of grease to be used in the gun.

e. IDENTIFICATION SYMBOLS. When all lubricants needed in the plant have been obtained, mark the product symbol on all containers, and on all grease guns and oilers used with a particular grade lubricant. The correct symbol should also be marked near oil cups and lubrication fittings to insure use of the right lubricant.

Table I. Lubricating oils

Standard product nomenclature	Product symbol	Grade or type	Temperature for use	Stock No.	Issuing service
Oil, engine	OE 10	SAE–10	——	14–0–2150	QMC
Navy symbol	NS 3050[1]	SAE 20	Above 0°F	14–0–2662	QMC
Oil, engine	OE 30	SAE 30	——	14–0–2154	QMC
Navy symbol	NS 3080	SAE 40	Above 15°F	14–0–2670	QMC
Oil, engine	OE 50	SAE 50	——	14–0–2156	QMC
Navy symbol	NS 2075	2075	Above 10°F	14–0–2586	QMC
Navy symbol	NS 2110[1]	2110	Above 0°F	14–0–2595	QMC
Navy symbol	NS 2135	2135	Above 0°F	14–0–2610	QMC
Navy symbol	NS 2190	2190	Above 35°F	14–0–2605	QMC
Navy symbol	NS 2190T[2]	2190T	Above 35°F	14–0–2879	QMC
Navy symbol	NS 2250[3]	2250	Above 35°F	14–0–2640	QMC
Navy symbol	NS 3065[3]	3065	Above 5°F	14–0–2663–8	QMC
Navy symbol	NS 3100	3100	Above 25°F	14–0–2685	QMC
Navy symbol	NS 3120	3120	Above 30°F	14–0–2700	QMC
Navy symbol	NS 4065	4065	Above 35°F	14–0–2715	QMC
Navy symbol	NS 5150	5150	——	14–0–2745	QMC
Navy symbol	NS 5190	5190	——	14–0–2760	QMC
Navy symbol	NS 6135	6135	——	14–0–2775	QMC
Navy symbol	NS 8190	8190	——	14–0–2820	QMC
Lubricant, exposed gears, chains and wire rope	CW 2	Grade 2	——	14–L–165	QMC
Oil, clock and watch	OCW	Allyear	Above 22°F	14–0–680	ORD
Oil, typewriter	TW	One grade	——	53–0–253	QMC
Lubricant, gear, universal	GO 90	90	Above 32°F	14–L–188–5	QMC

[1] Quenching.
[2] Turbine, noncorrosive, 55-gallon container.
[3] Machine, extra-heavy.

Caution: NS 4065, 6135, and 8190 are compounded oils and should never be mixed with steam-turbine oils or engine oils in circulating systems, ring-oiled bearings, or inclosed crankcases employing splash feed, as they will cause the oil to emulsify. **Do not use E 50 in an engine crankcase.**

Note. Navy symbol (NS) oils are classified by the first digits as follows:
2—Forced-feed oils, low-viscosity index.
3—Forced-feed oils, medium-viscosity index.
4—Compounded marine-engine oils.
5—Mineral cylinder oils.
6—Compounded steam-cylinder oils (tallow).
8—Compounded air-cylinder oils.

In class 2 oils the second, third, and fourth digits indicate viscosity in Saybolt Universal (SBU) seconds at 130°F. In all other classes, digits indicate SBU seconds viscosity at 210°F.

Table II. Greases

Standard product nomenclature	Product symbol	Grade or type	Temperature for use	Stock No.	Issuing service
Grease, general-purpose	CG 0	No. 0	Below 32°F	14–G–1179–5	QMC
Grease, general-purpose	CG 1	No. 1	Above 32°F	14–G–1220–5	QMC
Grease, general-purpose	WB 2	No. 2	All temps	14–G–1230–5	QMC
Grease, water-pump	WP	No. 4	——	14–G–1384–5	QMC
Grease, No. 0	OG 0	One grade only	Above 32°F	14–G–1425–605	ORD
Lubricant, plug valve	LV	Sticks, ⅜ dia.	——	14–5570–640–024	CE
Grease, graphited, light	GG	One grade only 1-lb. can	——	14–G–938–16	ORD
Compound, anti-seize, mica base	AS	One grade only 1-lb. can	——	52–C–3081	ORD
Grease, ball and roller bearing[1]	BR	One grade only 25-lb. pail	All temps	14–G–984–25	ORD

[1] Gargoyle BRB No 4, Socony-Vacuum Oil Co.
Proprietary brand acceptable. Government specification not yet available.

Table III. Preservative lubricating oils

Standard product nomenclature	Product symbol	Grade or type	Temperature for use	Stock No.	Issuing service
Oil, lubricating preservative, medium	PM	Medium	Above 32°F	14–0–2833–125	ORD
Oil, engine, preservative	PE 10	Grade 1 (SAE 10)	Above 10°F	14–0–2370–5	ORD

Table IV. Corrosion preventives

Standard product nomenclature	Product symbol	Grade or type	Temperature for use	Stock No.	Issuing service
Compound, rust-preventive, light	CL	Light	Up to 120°F	14–C–349–880	ORD
Compound, rust-preventive, thin film	CT	One grade only	——	14–C–507–10	ORD

Note. Rust-preventive compounds may require heating before they can be applied.

Table V. Recommended uses for lubricants.

Equipment	Oil or grease
Air compressors	
Vertical- and closed-crankcase type, single-acting, single-stage-crankcase type, supplying splash lubrication to compressor cylinders and bearings	
For gauge pressure of 100 psi or less	NS 2110, NS 3050
For gauge pressure over 100 psi	NS 2135, NS 2190, NS 3050
Horizontal multistage type air cylinders	NS 2135, NS 2190, NS 3050
External lubrication, sight feed and wick oil cups or hand oiling	NS 2135, NS 2190, NS 3050
External lubrication, circulating systems or splash type crankcases	NS 2110, NS 2135, NS 3050
Cylinders: wet conditions	NS 8190
dry conditions	NS 2190, NS 2250, NS 3065
Bearings	
Ball; all temperatures	BR
Ball; low-pitch line speed	
Operating temperature below 32°F	NS 2075
Operating temperature 32° to 150°F	NS 2190, NS 2250, NS 3065
Ball, medium-pitch line speed	
Operating temperature below 32°F	NS 2075
Operating temperature 32° to 150°F	NS 2135, NS 3050
Ball, high-pitch line speed	
Operating temperature below 32°F	NS 2075
Operating temperature 32° to 150°F	NS 2110, NS 3050
Ring-oiled, small, miscellaneous	NS 2110
Kingsbury thrust bearing	NS 2190T
Thrust (other than Kingsbury, subject to water)	NS 4065
Thrust (other than Kingsbury, not subject to water)	NS 2135, NS 2190
Bronze guide	WB 2
Countershaft	CG 1
Differential (inclosed)	NS 3150, NS 5190, NS 6135
Eccentric	NS 3065, WB 2
Guide	CG 0, CG 1
Oilite bronze bushings	OE 10, OE 30
Pillow block	WB 2
Underwater-babbitted	CG 0, CG 1
Universal joint, slip splines	GO 90, BR
Chain drives	
Roller	OE 30, NS 3080, CG 0, CG 1
Roller (inclosed)	Winter, NS 1075; Summer, NS 3065
Roller (semiinclosed)	Winter, NS 3080; Summer, NS 6135
Slow-speed	CW 2, OE 30
Medium-speed	NS 5190
Couplings	NS 6135
Drive jaw clutch	OE 50
Gear case or gear head	Low temperature, NS 3080; High temperature, NS 5190
Gears	
Herringbone	Winter, NS 2075; Summer, NS 3065
Helical	Winter, NS 2075; Summer, NS 3065
Motor reducers	Winter, NS 3050; Summer, NS 2135
Open	NS 5190, WB 2
Planetary	Winter, NS 2075, NS 2110; Summer, NS 2135
Worm and pump transmission	Winter, NS 3080, NS 3100; Summer, NS 6135
Packing, sludge pumps	OE 30, NS 4065, NS 6135
Seal Packings	WP
Shafting	
Large	NS 2190, NS 3065
Small	NS 2110, NS 2135, NS 3050
Shear pins	OE 30, WB 2
Sheaves	CG 1, CG 0
Solenoid oilers	OE 10, NS 3050
Valve stems	WB 2

Note. When in doubt on proper lubricant to use, consult the post engineer.

8. Painting

Periodic painting is necessary to protect metal parts of equipment from corrosive action of sewage treatment plants. Frequency of painting varies from 1 to 10 years, depending on type of paint used, method of application, and conditions of wear. Always paint metal sur-

faces before corrosion becomes so severe that equipment is damaged. Surfaces must be prepared before they can be painted; sandblast metal surfaces if practical, or clean them thoroughly with sandpaper and a wire brush. Only specially prepared paints should be used on damp surfaces where drying temperatures are less than 40°F.

Note. Corrosion-preventive compounds (table IV) may be used in moist places and in pits, where paint would not last.

9. Care of Functional Structures

Functional sewage pumping and treatment structures such as wet and dry wells, chambers, settling tanks, digesters, trickling filters, and sludge-bed walls require periodic inspection, normally annually. All tanks, except digesters, should be emptied for this inspection. Masonry structures should be checked for spalling, porosity cracks, and breaks in expansion-joint seals. Wooden structures and appurtenances such as baffles, gates, dividing walls, flumes, and channel covers should be checked for rot, warping, and checking.

a. MASONRY STRUCTURES. (1) *Spalling.* If spalling is allowed to continue it causes progressively greater damage to the structure. It should be required as follows:

(*a*) Repair concrete surfaces with shallow spalling with special cements such as Cameo, Rugged-wear, Stonehard, or similar materials which permit carrying the patch to a feather edge.

(*b*) Patch deeply spalled or porous concrete with ordinary cement, using approximately the same mix as the original concrete. Rich grouts cause shrinking.

(*c*) Keep checked concrete from spalling by sealing the surface with bituminous, asphalt, or synthetic-resin-base paint suitable for contact with sewage.

(2) *Cracks.* Cracks also lead to more serious damage, especially to structures exposed to heavy freezing. Therefore, it is important that all cracks be repaired immediately on discovery. Whenever possible, repairs should be made from inside the tank. Asphaltic admixtures to grout or asphalt-covered cloth membranes may be required to allow for contraction and expansion. If there is no movement, repair cracks with special cements ((1) (*a*) above). If water is flowing from the cracks, use special quick-setting mortars, insert a drain, or alternately pump sodium silicate and calcium chloride solutions into the crack. (For informaton on the latter method, write to the Philadelphia Quartz Company, Philadelphia, Pennsylvania.) Check fixed-cover digesters for cracks that may allow gas leakage and repair with asphaltic roofing cement applied with mop or trowel.

b. WOOD STRUCTURES AND APPURTENANCES. Wood does not deteriorate under water, but wood at or above the waterline rots quickly unless it is coated annually or more often with creosote or other preservative. To determine the need for preservative, inspect channel and basin covers and well stairways for soundness and ability to carry loads safely. Check tie rods, bolts, and other supporting steel work for corrosion, and repaint or replace as required. Replace or patch warped boards where necessary, such as in division walls and gates on sludge beds.

c. FROST HEAVING OF TANKS. Drained tanks heave in cold weather if ground-water levels are high or if clay and silt form the subgrade on which the tank bottom rests. Heaving causes cracks in the bottom and walls; therefore, leaving the tank in service is sometimes preferable to draining. However, if draining is necessary, the bottom should be protected with hay, straw, or other insulating material, or the tank should be alternately filled and emptied when it is out of service.

d. ICE THRUST. If a tank is removed from service and water is left in to prevent flotation or frost heaving, take special precautions in cold climates to prevent formation on the tank's side which may cause serious damage.
To prevent thrust:

(1) Cut a slot in the ice and keep it open.

(2) Insert logs along walls; they prevent thrust if ice is not too heavy.

e. FLOATING OF TANKS. Unless tanks are equipped with underdrain systems, anchored to piling, or otherwise designed to resist flotation, precautions are necessary to prevent floating of drained tanks which are subject to hydraulic-uplift pressure; this pressure may affect tanks built on a previous strata or near a body of water. A tank likely to be floated by ground water should not be drained unless the ground-water level is lowered by well points or ground water valves within the tank.

10. Power and Water Failure

Emergency power failures may disturb sewage treatment processes or cause damage to equipment. To prevent this, prepare a list of actions, in order of their importance, to be followed in case of sudden power interruptions; post the list centrally in each plant. Because water-cooled units or equipment using continuous water pressure may be damaged if water is shut-off, precautions necessary in case of water failure must also be posted.

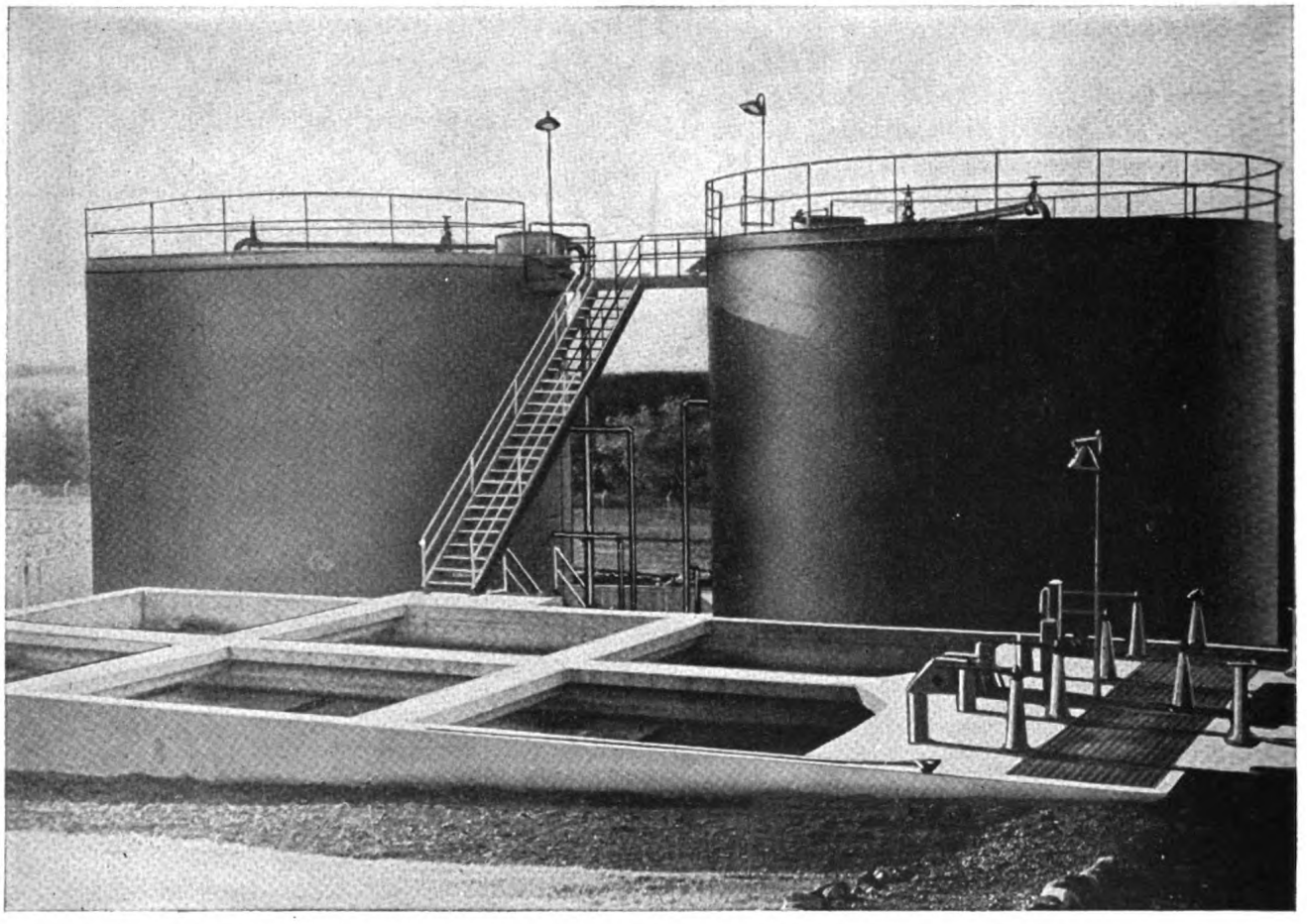
11. Explosion Hazards

Extreme precautions must be taken in sewage treatment plants to prevent the possibility of explosions.

a. CAUSES. Explosions result when sewage gases and air are mixed in proper proportions and ignited. These proportions vary with the nature of the gases involved, but generally range between 2 percent and 15 percent gas in the gas-air mixture. There are two main sources of potentially explosive gas:

(1) Leakage from gas mains or discharge of gasoline or other volatile substances into sewers.

(2) Decomposition of sewage solids in digestion tanks. (See fig. 4.)



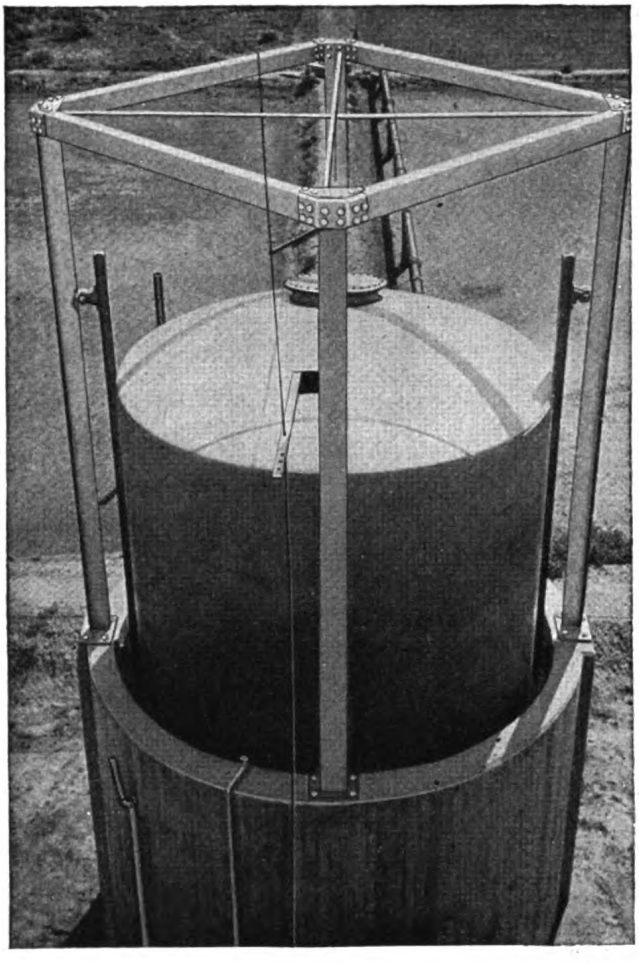
① Explosive mixtures of sewer gas and air are often formed in sludge digesters and sludge pits.

Figure 4. Potential explosion hazards.

b. PRECAUTIONS. Strict application of the safety rules below will help prevent explosions. The slightest infractions of these rules, however, can result in death or injury to personnel and extensive damage to equipment and structures, necessitating shut-downs and costly repairs.

(1) Do not smoke, drop lighted matches, or use open flames in or around sewers, screen chambers, sludge digesters, and settling tanks.

(2) Check periodically for gas leaks in piping joints, gas-valve stems, condensate-trap



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Sewage-gas storage tanks may explode when they are being repaired. To prevent explosion, break gas-inlet piping, erect blower on top manhole, and ventilate continuously.

Figure 4. Potential explosion hazards—Continued.

ports or valves, gas-meter connections, gas-pressure regulators, and the like. To test for leaks, spread a soap solution over joints, stems, and other possible openings and watch for gas bubbles.

(3) With an explosimeter, test all inclosed spaces for the presence of explosive gases.

(4) Before personnel are allowed to enter sewers, manholes, pits, or inclosed tanks, test for toxic or explosive gases and for oxygen deficiency, using any appropriate gas detector. *Never* allow one man to work alone in an inclosed space.

(5) When filling and emptying a digester tank, prevent formation of an explosive air-methane gas mixture under the tank cover by using forced ventilation to remove the gas. Continue ventilation until the work is completed.

12. Equipment Under Winter Conditions

Special care is necessary to protect operating and stand-by equipment against damage. Make sure lubricants are changed to winter grades. Drain equipment temporarily out of use or on stand-by service to prevent water from freezing in confined places and bursting units such as the central housing of rotary distributors, pumps, and similar items.

13. Removing Equipment from Service

a. SHORT PERIOD. Precautions should be taken to prevent damage to the equipment removed from service for a short period of time. Factors to be considered and precautions to be taken depend on the type of equipment and outside

conditions. (See fig. 5.) If the outage is likely to be long, turn the equipment over by hand or by motor weekly if possible.

b. PROTRACTED PERIOD. Special precautions are necessary for equipment which is to be out of service for long periods. Failure to retire equipment properly or otherwise protect it may cause damage during idleness or resumption of operation. Where it is known that the outage will be protected, dismantle the equipment and protect it against corrosion and other damage by use of suitable greases, oils, and rust-preventive compounds. (See par. 7 and tables II, III, and IV.)

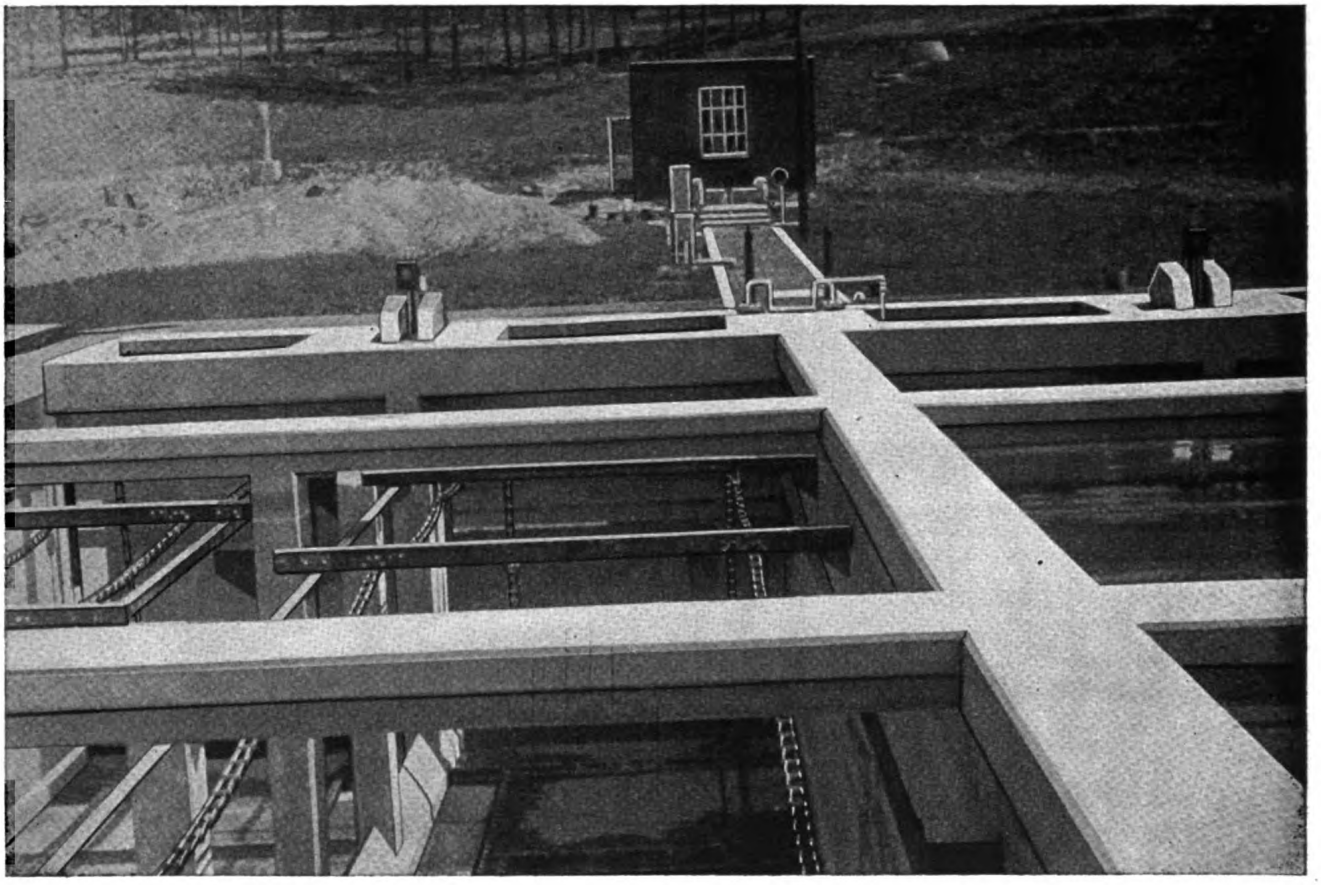


Figure 5. When sludge-concentration equipment is removed from service, take necessary action to protect chains, Sprockets, drive mechanism, electrical controls, exposed metal, and concrete.

SECTION IV

DRIVING EQUIPMENT AND ACCESSORIES

D	W	M	Q	S	A

14. Electric Motors

The post engineer's electrical staff is responsible for repairing motors. However, inspector mechanics or operators are responsible for the inspections in *a* and *b* below; in addition, the post engineer may make them responsible for services covered in *c*, *d*, and *e* below if they have the skill and the tools for the work required.

50 *a.* CHECK MOTOR CONDITION. (1) Keep motors free from dirt or moisture.

(2) Keep operating space free from articles which may obstruct air circulation.

51 (3) Check for oil leakage from bearings.

b. NOTE ALL UNUSUAL CONDITIONS. Report any of the following to the post engineer for correction by the electrical staff:

(1) Unusual noises in operation.

(2) Motor failing to start or come up to speed normally. Sluggish operation.

(3) Motor or bearings which feel or smell hot.

(4) Continuous or excessive sparking at commutator or brushes. Blackened commutator.

(5) Intermittent sparking at brushes.

(6) Fine dust under coupling having rubber buffers or pins.

(7) Smoke, charred insulation, or solder whiskers extending from armature.

(8) Excessive hum.

(9) Regular clicking.

(10) Rapid knocking.

(11) Brush chatter.

(12) Vibration.

(13) Hot commutator.

52 *c.* LUBRICATE BEARINGS. (1) Check oil level in sleeve bearings and replenish as needed. Use correct type and grade of oil. (See par. 7 and table V.) See that oil ring operates freely.

53 (2) Check grease in ball or roller bearings and replenish when necessary with grease. Follow instructions below when preparing bearings for grease.

54 *d.* FLUSH ANTIFRICTION BEARINGS. The following is the approved method of flushing antifriction bearings on horizontal shafts equipped with drain plugs; see also figure 6:

(1) Clean housing and pressure-gun and relief fittings. Remove both fittings. (See fig. 6(1).) Keep dirt out of bearings when greasing and cleaning. Once abrasive is in a bearing it cannot be removed even by most thorough cleaning.

(2) Use clean screw driver or similar tool to remove hardened grease

Abbreviations: D, means daily; W, weekly; M, monthly; Q, quarterly; S, semiannually; A, annually.

D | W | M | Q | S | A

from pressure-fitting hole in top of bearing housing. (See fig. 6(2).)

(3) Free old grease from relief-plug hole in bottom of housing (fig. 6(3)) to permit easy removal of old grease after solvent is added.

(4) While the motor is running, inject some grease solvent from a syringe into bearing housing through the pressure-fitting hole. (See fig. 6(4) and (5).)

(5) Continue to add solvent until all grease has drained out through relief hole, and clear solvent comes through. (See fig. 6(6).)

(6) Replace relief plug and inject solvent until it can be seen in filling hole. Allow solvent to churn for a few minutes then remove relief plug and drain. Repeat churning operation until solvent runs clear.

(7) If carbon tetrachloride is used as solvent, flush it out by replacing relief plug and injecting small amount of light lubricating oil. Allow to churn for 1 or 2 minutes before draining.

Note. Procedure may be slightly modified on motors where relief plug is not accessible.

54 *e.* REFILL ANTIFRICTION BEARINGS WITH GREASE. After cleaning, refill bearings as follows:

(1) Wipe pressure-gun fitting, bearing housing, and relief plug to make sure that no dirt gets into bearing with the grease.

(2) Before using grease gun, always remove relief plug from bottom of bearing to prevent excessive pressure in housing which might rupture bearing seals.

(3) Use clean screw driver or similar tool to remove hardened grease from relief hole and permit excess grease to run freely from bearing.

(4) While motor is running, add grease with hand-operated pressure gun until it flows from relief hole, purging housing of old grease. If lubricating running motor is dangerous, follow above procedure with motor at a standstill.

(5) Stop motor and replace relief plug tightly with a wrench.

† *f.* SERVICE MOTOR CONTROLS. See paragraph TM 5–681.

15. Gasoline Engines

All gasoline engines (fig. 7) must be operated for at least 15 minutes each week, under load if practicable.

* *a.* BEFORE-OPERATION SERVICE. Make the following checks before putting engine in operation.

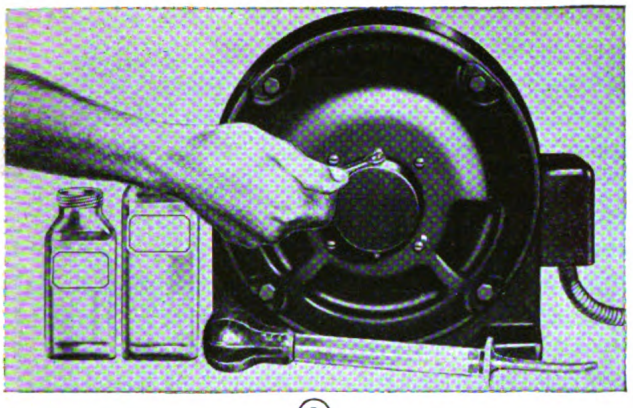
(1) *Check for tampering and damage.* Look for signs of tampering, damage, or injury, such as loosened accessories or drive belts.

(2) *Check fire extinguisher.* Check extinguishers for tight mountings, full charge, and closed valves. See that nozzles are not corroded.

(3) *Check fuel, oil, and water.* Check amount of fuel in tanks, noting signs of leaks or tampering. Add fuel if necessary. If fuel pipe is frozen, melt ice by wrapping pipe with cloth or waste soaked in hot water; *do not use open flame.* Check oil level and add oil if necessary. Check level and condition of coolant. During season when antifreeze is used, test coolant with hydrometer, and add antifreeze and water if necessary. Do not use alkali water.

Note. Investigate any appreciable change in fuel or water level since the last after-operation service and report it to proper authority.

(4) *Check accessories and drives.* Check all accessories such as car-



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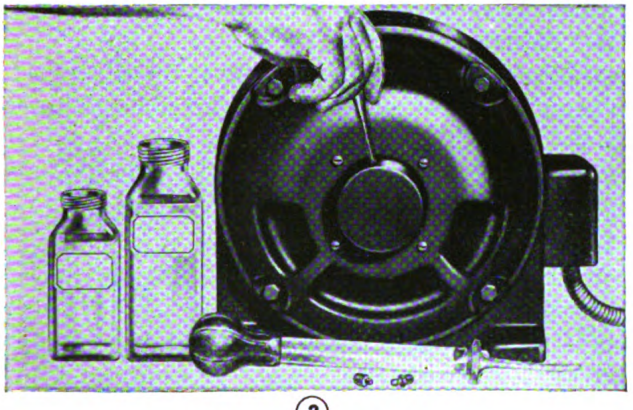

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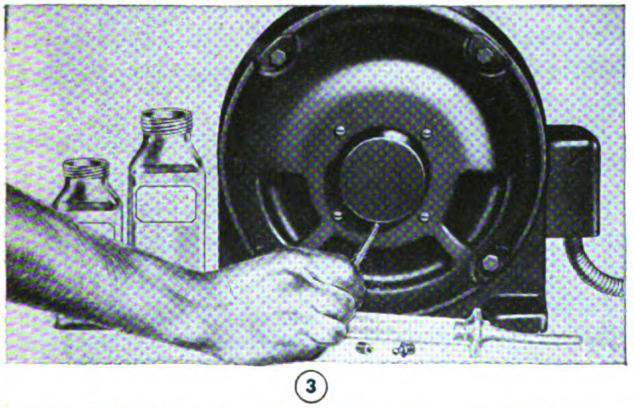

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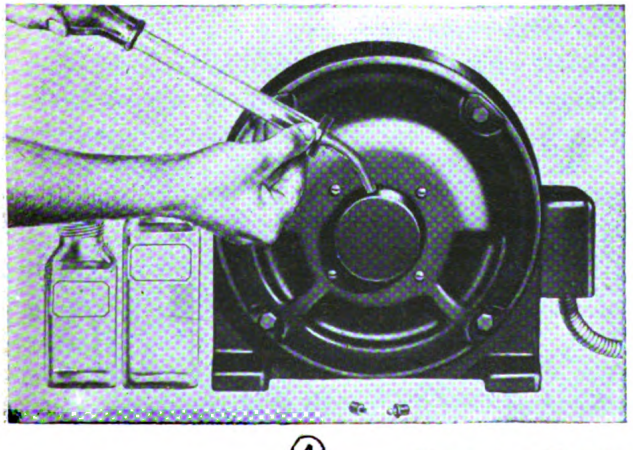

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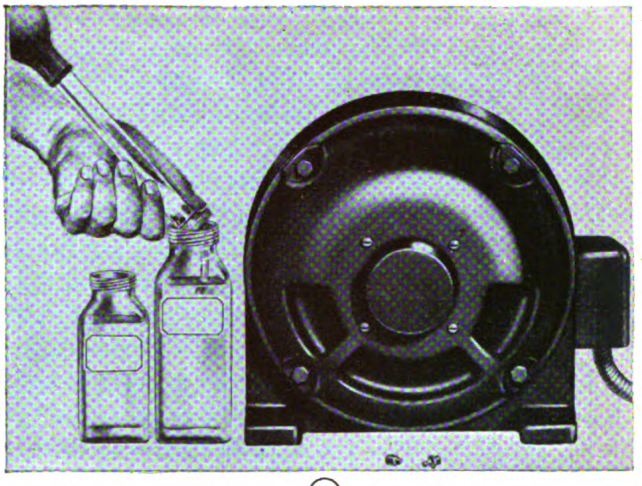

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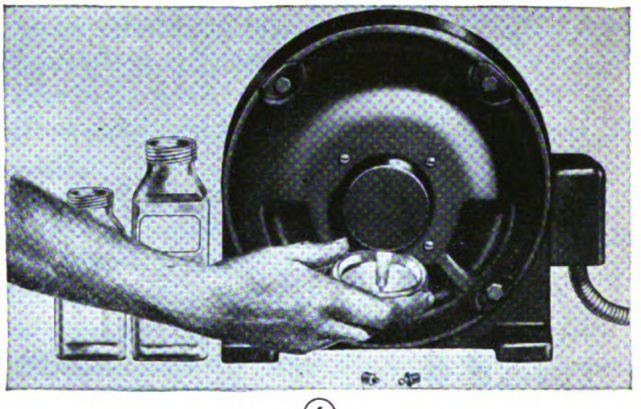

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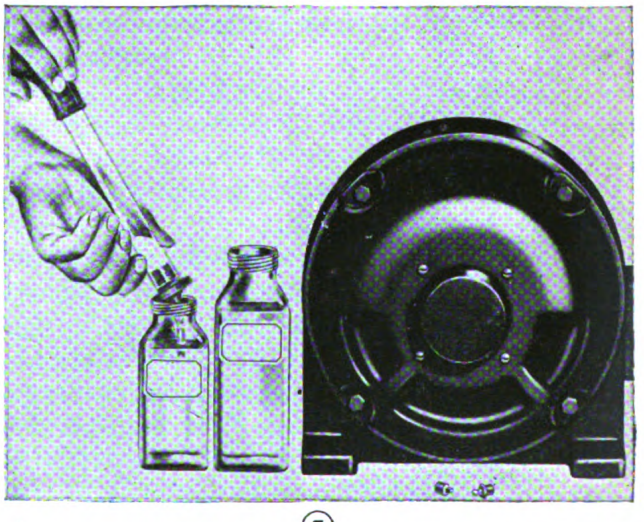

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Figure 6. Cleaning electric-motor bearings.

buretor, generator, regulator, starter, fan, shroud, and water pump for loose connections or mountings.

(5) *Check for leaks.* Look for signs of fuel, oil, water, or gear-oil leaks. Check cooling system for leaks, especially the radiator core and connecting hose. Check for leaks in engine crankcase, oil filters, oil tanks, oil coolers, and lines. Check fuel system for indications of leaks. Trace all leaks to their source and correct or report them to proper authority.

(6) *Observe engine warm-up.* Start engine and observe action of starter mechanism. See that starter has adequate cranking speed and engages and disengages properly without unusual noise. If oil-pressure gauge or signal light does not operate properly within 30 seconds, stop engine and correct trouble or report it to proper authority. Throttle engine to normal (fast idle) warm-up speed and continue servicing procedure.

Caution: Great damage is caused by placing engine under load before reaching normal operating temperature.

(7) *Check choke or primer.* While starting engine, check operation of choker or primer. As engine warms up, reset choke to prevent overchoking and dilution of engine oil.

(8) *Check oil-pressure gauge or light indicator.* Observe operation of oil-pressure gauge or light indicator. If these instruments do not operate properly, stop engine immediately, investigate cause, and report it to proper authority. Do not let pressure drop below 10 psi at normal operating speed.

(9) *Check instruments.* (*a*) *Ammeter.* Ammeter should show a high charging rate for first few minutes after starting, until current used in starting is restored to the battery. After this period, ammeter should register zero or slight positive charge with accessories turned off and engine operating at fast idle. Investigate any unusual drop or rise in reading. An extended high reading may indicate a dangerously low battery or faulty generator regulator.

(*b*) *Tachometer.* Note whether tachometer indicates the approximate engine rpm.

(*c*) *Fuel gauge.* Observe fuel gauge for proper operation.

(*d*) *Voltmeter.* Check voltmeter for proper operation. It should register at least nominal battery voltage, usually indicated by a red line on instrument.

(*e*) *Temperature gauge.* Engine temperature should increase gradually during warm-up period. If temperature remains extremely low after a reasonable warm-up period, engine may need thorough check-up.

(10) *Check engine operation.* If temperature gauge does not indicate normal operating temperature but engine operates under load with the choke fully released and oil gauge indicates approximately normal operating pressure during engine acceleration, normal operating temperature may be assumed. Gradually accelerate engine several times after it has reached normal operating temperature, and investigate and correct any unusual noise or unsatisfactory operating characteristics.

b. DURING-OPERATION SERVICE. Make following checks during operation.

(1) *Check clutch.* See that clutch does not grab, chatter, or squeal during engagement or slip when fully engaged. If clutch lever does not have enough free travel before clutch begins to disengage, clutch may slip when under load. Too much free travel may keep clutch from disengaging fully, causing clashing gears and damage when shifting.

D	W	M	Q	S	A

(2) *Check transmission.* See that gears shift smoothly, operate quietly, and do not creep out of mesh during operation. Gears jumping out of mesh may indicate wear in shifting mechanism or gear teeth, or incorrect alignment of transmission or clutch housing.

(3) *Check engine and controls.* Watch for poor engine performance such as lack of usual power, misfiring, unusual noise, stalling, overheating, or excessive exhaust smoke. See that engine responds to controls satisfactorily and that controls are correctly adjusted.

(4) *Check instruments.* Observe all instrument readings frequently for proper operation. (See par. 15*a*(9).) Do not let oil pressure drop below 10 pounds at normal operating speed.

* *c.* SHORT-STOP SERVICE. Short-stop service is performed whenever the engine is stopped for a brief period. It includes correcting defects noted during operation and making the following inspections:

(1) *Check fuel, oil and water.* (*a*) Make sure there is enough fuel to last through the contemplated shift operation. When refueling, use safety precautions for grounding static electricity. Allow space in filler neck for expansion. See that filler-vent caps are open and pressure-cap valves are free. Replace cap securely.

(*b*) Check crankcase oil level and add oil if necessary. Make sure oil drain is closed tightly.

(*c*) Remove radiator filler cap, being careful of steam, especially if a pressure cap is used. Check for proper level of coolant and replenish as necessary. Do not fill to overflowing, but leave enough space for expansion. If engine is hot, fill slowly while engine is running at a fast idle.

(2) *Check leaks.* See paragraph 15*a*(5).

(3) *Check accessories and belts.* See that fan, water pump, and generators are secure and their drive belts are adjusted and undamaged.

(4) *Check air cleaners.* When operating under extremely dusty conditions, inspect air cleaners and breather caps to see that they can deliver clean air properly. Service if necessary.

* *d.* AFTER-OPERATION SERVICE. When performing after-operation service, operators must consider any irregularities noticed during before-operation, during-operation, and short-stop services. Any engine requiring inspection or service while still at operating temperature should be inspected as soon as possible. After-operation service consists of making the following checks and correcting or reporting any deficiencies.

(1) *Check fuel, oil, and water.* See paragraph 15*c*(1).

(2) *Check engine operation.* See paragraph 15*a*(11).

(3) *Check instruments.* See paragraph 15*a*(9).

(4) *Check battery and voltmeter.* See that battery is not leaking and that battery, cables, and vent caps are clean and secure. Check voltmeter to see that it registers at least nominal battery rating, usually indicated by a red line on instrument.

(5) *Check accessories and belts.* Inspect carburetor, generator, regulator, starter, fan, shroud, water pump and other accessories for loose connections or mountings. Check adjustment of fan and accessory drive belts. Belts should deflect as specified in paragraph 16. Replace unserviceable belts.

(6) *Check electrical wiring.* Make sure all ignition wiring is securely connected, clean, and not damaged.

(7) *Check air cleaner and breather caps.* See that oil in air cleaner is

D	W	M	Q	S	A

at correct level. Rub a drop of oil between fingers. If it feels dirty, drain and refill with fresh oil. If operating in dusty area, remove and clean air cleaners and breather caps.

(8) *Check fuel filters.* Turn handle of Cuno type filters one complete turn. Check all fuel filters for leaks.

(9) *Check engine controls.* Check for worn or disconnected linkage. Correct or report any unsatisfactory engine-control linkage operation.

(10) *Check for leaks.* Locate all fuel, oil, or water leaks and correct or report them.

(11) *Check gear-oil levels.* Check level of lubricant in drives and transmissions after they have cooled at least enough to be touched by hand. Hot or foamy lubricant does not give a true lubricant-level indication.

e. ADDITIONAL SERVICES. Perform the following additional services weekly:

62 (1) *Check battery and voltmeter.* Clean dirt from top of battery. If terminal connections or posts are corroded, clean them thoroughly and apply thin coating of CG 1 grease. Tighten loose terminal bolts. Remove vent caps and check electrolyte level. Add water if required, taking precautions so battery will not be damaged by freezing. Battery should be secure and not bulking, cracked or leaking electrolyte. If mountings are loose, tighten them carefully to avoid damaging battery case.

63 (2) *Check accessories and belts.* Tighten or adjust loose connections, linkage, or mountings of accessories. Examine all belts for fraying, wear, cracking, or presence of oil. (See par. 16.) Check all belts halfway between their pulleys to see whether tension is correct. Make necessary adjustments.

64 (3) *Inspect electrical wiring.* See that all accessible wiring is securely connected and supported, that insulation is not cracked or chafed, and that conduits and shielding are in good condition and secure. Report any unserviceable wiring.

65 (4) *Check air cleaners and breather caps.* Remove and disassemble air cleaners. Clean bodies and elements in kerosene. After cleaning dry type air cleaner, oil sparingly with crankcase oil, drain, and replace. Do not allow oil in oil-bath cleaners to become excessively dirty or oil reservoir to get more than one-fourth full of sediment. Clean oil cup. Refill cup to proper level with same grade of crankcase oil. Wash out filter unit thoroughly with kerosene. Dry and reassemble. Reinstall air cleaners, giving special attention to mountings and alignment. Make sure all gaskets are in good condition and in place. If flexible steel tubing is used, wrap securely with tape and paint. See that all ducts connecting air cleaners to carburetors are secure and undamaged. Remove all breather caps and crankcase-filter cleaning elements. Wash them thoroughly in kerosene, dip in crankcase oil, drain off excess, and reinstall. Clean and service oil-bath type breathers in the same way as oil-bath air cleaners.

66 (5) *Fuel filters.* Close shut-off valve to fuel line. Remove drain plug and drain water and sediment from filter bowl. Replace drain plug, tighten it securely, and reopen shut-off valve in fuel line. Make sure fuel is not leaking from drain plug. If filter has two plugs in bottom of bowl, the plug nearer the edge is for draining.

83 (6) *Lubricate.* (*a*) Drain oil from crankcase while engine is hot, and refill with new OE 10 or OE 30. See that oil drain is tightly closed. On stand-by service only, 64 hours of engine operation is considered as 1 week.

D	W	M	Q	S	A
	1				
	3				
		6			
		9			
		14			
		18		18	

(*b*) Oil control-rod points. Lubricate control-rod points between carburetor and governor with OE 10.

(*c*) Check generator and starting motor. Fill generator oil cups with a few drops of OE 10.

f. RUNNING TEST OF ENGINE AND ACCESSORIES. The running test of engine and accessories requires careful, competent performance and provides more thorough maintenance. Checks requiring semiannual performance correspond to the 6,000-mile maintenance and technical inspection for Army vehicles.

(1) *Before-operation inspection.* Follow procedure given in paragraph 15*a*.

(2) *Instruments and gauges.* (*a*) *Oil.* Observe oil gauge at frequent intervals under all engine speeds to see that oil pressure meets manufacturer's specifications and that viscometer reading is normal.

Caution: If gauge indicates zero or excessively low oil pressure, stop engine immediately and investigate cause.

(*b*) *Ammeter and voltmeter.* See par. 15*a*(9). Press voltmeter switch to see that voltage is properly indicated. Ammeter needle should show only slight fluctuation.

(*c*) *Tachometer.* Check tachometer for proper operation, excessive fluctuation, and unusual noises indicating faulty gears or cable.

(*d*) *Temperature.* See paragraph 15*a*(9). After warm-up, temperature should not normally exceed 180°F. Temperature above normal may indicate thermostat is stuck closed or that cooling system is clogged.

(3) *Clutch.* Clutch lever should have at least the minimum free travel recommended by manufacturer before meeting resistance other than the pull-back spring. Disengage clutch fully. If the transmission cannot be shifted into gear after a few seconds without clashing, clutch is dragging. Operate engine at various speeds and listen for noises indicating dry release bearings or defective release bearing, clutch plate, or pilot bearing. Any jerky motion or sudden engagement indicates chatter or grabbing.

(4) *Engine.* Observe following characteristics of engine operation:

(*a*) *Noises.* Listen for knocks and rattles as engine is accelerated and decelerated under light and heavy loads.

(*b*) *Acceleration and power.* Operate engine at various speeds to check for normal power and acceleration. Note any tendency to stall while shifting. A slight pinging during rapid acceleration is normal; continued or heavy pinging may indicate early timing, heavy carbon accumulation, or low-octane fuel.

(*c*) *Governed speed.* See that engine speed does not exceed the specified rpm.

(*d*) *Unusual noises.* Be alert for unusual noises indicating loose parts and damaged or improperly functioning units in the power train.

(5) *Leaks.* See paragraph 15*a*(5).

(6) *Engine head.* Inspect cylinder head and gasket. Look for cracks or oil, water, or compression leaks around studs, cap screws, and gasket. Make necessary corrections.

Caution: Cylinder heads should not ordinarily be tightened unless there are definite signs of looseness or leaks. If tightening is necessary, use a torque-indicating wrench and tighten in sequence to tension specified by manufacturer. When a new gasket is installed, tighten three times: on installation, again after engine is warmed up, and finally after final run-

W	M	Q	S	A	
					ning test. On valve-in-head engines, adjust tappet clearance to specifications after final tightening of head nuts.
	19		19		(7) *Valve mechanism.* (*a*) Examine valve-tappet clearances on valve-in-head engines while engine is hot. Valve tappets, rocker arms, and springs should appear in good condition, correctly assembled, and secure. Oil should be delivered properly. See that valve cover gaskets are in good condition. Perform above service on L-head engines only when need is indicated by valve noises or engine performance.
			19		(*b*) Observe valve clearances and condition of valve mechanisms. Adjust clearances to specifications, taking care that locknuts are secure when clearances are last checked during the adjustment.
	20				(8) *Spark plugs.* (*a*) Make sure spark plug insulators are in good condition and clean, and no leakage is occurring around insulator or gaskets. Remove spark plugs and check for broken insulators, excessive carbon deposits, and electrodes which are burned thin. Replace unserviceable plugs. Report excessive deposits or damaged insulators which may be signs of incorrect heat range.
			20		(*b*) Clean deposits from the electrodes and insulators, and check again for cracks. If a plug cleaner is not available, install new or conditioned plugs.
			20		(*c*) Adjust gaps to specifications by bending to grounded electrodes. After completing item 21 below, reinstall plugs, using new gaskets. Take care not to overtighten them to avoid distortion and damage.
	21		21		(9) *Compression test and record.* With all spark plugs out, insert compression gauge in a spark plug hole and rotate engine at cranking speed with the throttle wide open until maximum compression is indicated. Do not crank engine more than necessary to get maximum reading. Be sure battery is fully charged. Record reading on WD AGO Form 5–34. Repeat process for each cylinder. See manufacturer's instructions for specified compression pressures and variations due to altitude and wear. If pressure in cylinder is appreciably below normal, squirt enough engine oil on piston head to prevent loss of compression temporarily, then recheck. If low compression can be brought to normal by oil sealing, piston, ring, or cylinder wear or damage is indicated. If low compression is not brought to normal by this method, valve or gasket leakage is indicated.
	22		22		(10) *Battery.* (*a*) Inspect battery case for cracks or leaks. Clean top of battery. Inspect cables, terminals, bolts, posts, straps, and hold-downs for proper condition and grease them lightly. Test specific gravity and voltage and record on service record. Specific gravity readings below 1.225 indicate battery should be recharged or replaced. Bring electrolyte to proper level by adding distilled water. Electrolyte level should be above top of plates and may extend ½ inch above them. Tighten terminals and hold-downs carefully to avoid damage to battery.
			22		(*b*) Perform high-rate discharge test. Follow instructions for condition test which accompany test instrument. Record voltage on service record; cell variation should not be more than 30 percent.
					Note. Specific gravity must be above 1.225 to make this test.
	23		23		(11) *Crankcase.* With engine idling, examine crankcase, valve covers, timing gear, and clutch housing for oil leaks. Stop engine; after oil has drained into crankcase, see that oil is at proper level.
					Note. If oil change is due, drain crankcase and refill to proper level with specified oil. Do not start engine until item 24 is completed.

D	W	M	Q	S	A
		24			
		24			
				24	
		25			
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		26		26	
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				27	
		29		29	

(12) *Oil filters, coolers, and lines.*

(*a*) *Inspect oil filters, coolers, and all external engine-oil lines.* See that they are in good condition, secure, and not leaking.

Note. When oil-filter cartridge change is due or its condition indicates need for change, remove filter cartridge, clean case, and install new cartridge of the correct type, using new gaskets and tightening cover securely.

(*b*) *Clean disk type filters.* Turn handle one complete turn, remove drain plug, and drain contents.

(*c*) *Clean and service filters.* Remove cover and element of disk type filters and clean them in kerosene without reassembling. Reinstall element if serviceable; if not, replace element or entire filter assembly.

(13) *Radiator.* (*a*) See that radiator core, shell, shutters, mountings, hose, cap, gasket, overflow tank, and steam-relief tube and valve are in good condition, correctly assembled, securely mounted and connected, and do not leak. Make sure core air passages are not obstructed with dirt, insects, or trash. Look for badly bent core fins. See that steam-relief valve operates freely and is in correct position for prevailing atmospheric temperature. Examine coolant for rust, oil, or other foreign matter; clean cooling system if necessary. Before cleaning the system, drain radiator. If ethylene-glycol antifreeze is used, save drainings and pour back into radiator after radiator is cleaned. Clean cooling system according to current directives, using only specified cleaner. Flush cleaner from entire cooling system with clean water. Refill radiator with coolant, adding specified inhibitor unless new antifreeze containing inhibitor is used. Allow room at top for expansion. If antifreeze is in use, determine its protective value and record in space provided on service record.

(*b*) Clean dirt from core with compressed air or stream of water applied carefully from the rear of core. DO NOT USE STEAM.

Caution: If fins are bent, use only a suitably shaped piece of wood or blunt instrument to straighten them; otherwise tubes may be punctured.

(14) *Water pump, fan, and shroud.* (*a*) Observe water pump to see that it is in good condition, not leaking, and securely installed. Loosen drive belts and leave them loose until item 29 is completed. Examine shaft for end play and loose bearings. Inspect fan blades to see that they are in good condition and properly secured to the hub. Make sure shroud is in good condition, properly aligned with fan, and securely mounted.

(*b*) Tighten packing-gland nut cautiously. Overtightening causes scoring of shaft and consequent leakage.

(15) *Generator, starter, and switch.* (*a*) See that starter, generator, and switch are in good condition, securely mounted, and that wiring connections are clean and secure. Check condition and security of starter linkage and retracting spring. Remove generator and starter inspection covers and see that commutators and brushes are in good condition and not excessively worn; that brushes are free in holders and have enough spring tension to hold them in contact with commutator; and that brush-connecting wires are secure and not chafing.

(*b*) Clean commutator end of generator and starter with compressed air. If commutator is dirty, clean with fine (00) sandpaper. Blow out dust with compressed air.

(*c*) Tighten starter mounting bolts.

(16) *Drive belts and pulleys.* Check all drive belts for fraying, excessive wear, and deterioration. See that all drive pulleys and hubs are in good

W | M | Q | S | A

condition and securely mounted. Adjust all accessory drive belts to specified tension.

30 30 (17) *Tachometer drive and adapter.* See that tachometer drive and adapter are in good condition, correctly assembled, and secure. Inspect flexible-driveshaft connection for oil leaks.

31 (18) *Distributor.* (*a*) See that distributor body and external attachments are in good condition and secure.

1. Blow or wipe dirt or dust from distributor cap. Remove cap and see that cap, rotor, and breaker-plate assembly are in good condition, correctly assembled, secure, and serviceably clean. Pay particular attention to cracks in cap and rotor, corrosion of terminals and connections, and to burning of outer ends of the conductor strap of the rotor.

2. See that breaker points are in good condition, well aligned, and adjusted to manufacturer's specifications.

3. If breaker-plate assembly is unserviceably dirty, remove distributor, clean in kerosene or dry-cleaning solvent, dry with compressed air, lubricate parts as shown in item 31 below, and reinstall in correct position for timing.

4. When cleaning distributor, remove wick and lubrication cup, clean and dry them, and reinstall only after distributor assembly is cleaned and blown dry with compressed air.

5. If breaker points are pitted, burned, or worn to unserviceable condition, install a new set of points. If points are badly pitted, replace condenser, which probably caused the pitting.

6. Install new points so they are well aligned and engage squarely.

7. If points are slightly pitted or burned, dress them with an American-Swiss No. 6 file or equivalent, or with 00 sandpaper; do not use emery cloth. Remove filings with compressed air.

31 (*b*) Check tightness of shaft by hand to determine whether distributor camshaft is excessively worn in its bushings.

31 (*c*) See that vacuum-advance mechanism and its vacuum lines are in good condition, correctly assembled, and secure; that vacuum-advance mechanism can be moved by finger force through its normal movement; that diaphragm spring returns mechanism to original position when finger force is removed; and that mechanism does not bind or hang up during this check.

31 31 (*d*) Wipe breaker cam lightly with CG 1 and lubricate breaker-arm pivot and wick under rotor with 1 to 2 drops of SAE 30. Take care to keep lubricant away from distributor points, to apply no more lubricant than specified, and to wipe cam clean before lubricating its surfaces.

31 (*e*) Adjust breaker-point gap according to manufacturer's instructions.

32 32 (19) *Coil and wiring.* See that coil is in good condition, clean, and securely mounted. All high-voltage ignition wiring, including shielding of conduits, should be in good condition and securely fastened to all support mountings and terminals. See that all insulation and connections are clean. Inspect all low-voltage wiring in engine compartment in same manner.

Note. Do not tighten wiring connections unless they are actually loose because overtightening terminals causes damage.

33 (20) *Manifolds and heat control.* (*a*) See that intake and exhaust manifolds are in good condition, secure, and that manifold gaskets are in good condition and not leaking. Make sure the control-adjusting pointer on a manually operated manifold heat control is set at correct seasonal position.

D	W	M	Q	S	A	
						If control is automatic, see that bimetal control spring is in good condition and securely connected to heat-control valve shaft and mounting, that shaft operates freely, and that spring controls shaft and valve properly.
				33		(*b*) Tighten all manifold-assembly, mounting, exhaust-pipe, and carburetor connecting-flange nuts evenly and securely.
		34		34		(21) *Air cleaners.* (*a*) Remove all air-cleaner elements. See that all gaskets, seals, clamps, and connecting hose or tubes are present and in good condition. Observe condition of cleaning elements, baffles, and body. Check level and cleanliness of oil in reservoir of oil-bath cleaners.
		34		34		(*b*) Refill with OE 30. Install air cleaner, being careful to press it firmly into place. See that mounting is secure. If air cleaner has an external air baffle, see that it is correctly aligned with air stream from fan. Make sure connecting hose is in good condition and properly clamped to air cleaner.
		35		35		(22) *Breather caps and ventilators.* See that breather caps and ventilators are in good condition, correctly assembled, secure, and that ventilator tubes are open.
		36		36		(23) *Carburetor, choke, throttle, linkage, and governor.* See that carburetor, choke, throttle, linkage, and governor are in good condition, correctly assembled, and securely installed; that carburetor does not leak; that control linkage, including choke and throttle shaft, is not excessively worn; that choke valve opens fully when control is in released position; that throttle valve opens fully when accelerator is fully depressed; and that governor is secure and properly sealed.
		37		37		(24) *Fuel filters, screen, and lines.* (*a*) Examine all fuel filters and sediment bowls, fuel lines, and connections to make sure they are in good condition, secure, and not leaking.
						(*b*) Close fuel shut-off valve and remove filter bowls, gaskets, and filter elements or screens. Without disassembling disk type filters, clean filter elements, sediment bowls, and screens in kerosene. Dry elements thoroughly, including any screen or filter element at carburetor fuel-line connection or at fuel pump. Reinstall removed parts, using new gaskets. Turn on fuel shut-off valve after assembling, and recheck for leaks.
						Note. If filter element or screen is damaged or clogged beyond cleaning, replace it.
		38				(25) *Fuel pump.* (*a*) See that fuel pump and lines are in good condition, secure, and not leaking.
					38	(*b*) Attach a fuel-test gauge and, with engine idling, note that pump pressure is within limits specified by manufacturer. Replace any pump that does not produce proper pressure, being sure to make a similar check of new pump.
		39		39		(26) *Starter.* Inspect starter for action, noise, and speed. Start engine, noting whether general action of starter is satisfactory, particularly whether it engages and operates properly without excessive noise. Check to see that starter has adequate cranking speed and that engine starts readily. As soon as engine starts, see that oil-pressure gauge and ammeter indications are satisfactory.
		40		40		(27) *Leaks.* See paragraph 15*a*(5).
		41		41		(28) *Ignition timing.* With engine running and neon timing light connected, observe ignition timing. See that automatic controls advance timing as engine is accelerated gradually. Adjust timing to conform with manufacturer's instructions.

D	W	M	Q	S	A
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				42	
		43			
				43	
			44		
		45			
				46	
				47	

(29) *Engine idle and vacuum test.* (*a*) See that engine operates smoothly at normal idling speed. Connect vacuum gauge to intake manifold, adjust engine to normal idling speed by throttle stop screw, and adjust idling mixture adjusting needle until vacuum gauge indicates steady maximum reading. If latter adjustment changes idling speed appreciably, reset idling speed and mixture until both are satisfactory. Time can be saved by making both adjustments simultaneously.

(*b*) Make vacuum test. With engine running at normal idling speed, vacuum gauge should read about 18 to 21 inches and pointer should be steady. A needle fluctuating badly between 10 and 15 inches may indicate a defective cylinder-head gasket or valve. An extremely low reading may indicate a leak in intake manifold or gasket. Accelerate and decelerate engine quickly. If gauge indicator fails to drop to about 2 inches as throttle is opened and fails to recoil to at least 24 inches as throttle is closed, diluted oil, poor piston-ring sealing, or abnormal restriction in the carburetor, air cleaner, or exhaust may be indicated.

Note. The above readings apply to sea level. They are about 1 inch less for each 1,000 feet of altitude.

(30) *Regulator unit.* (*a*) See that regulator unit is in good condition and that connections, seals, and mountings are secure.

(*b*) Connect low-voltage circuit tester and see that voltage regulator, current regulator, and cutout control the generator output properly. Follow instructions which accompany test instrument. Replace if test shows faulty operation.

Caution: This test should be made only after regulator unit has reached normal operating temperature.

(31) *Gasoline tank.* Drain gasoline to prevent gumming of carburetor and fouling of engine by deteriorated gasoline. Refill tank with fresh gasoline. If carburetor and engine are gummed, remove deposits with acetone or alcohol. If gum has dried, use of solvent may not be satisfactory and scraping may be necessary to remove gum.

(32) *Flexible-shaft universal joints and spline.* Every 256 hours of operation of stand-by engines, force GO 90 into Zerk fittings at shaft points.

At 1,024 hour intervals, disassemble, clean in solvent, and lubricate all fittings with GO 90.

(33) *Power take-off clutch pilot bearings and shaft-bearing throw-out collar.* Every 8 hours of operation of stand-by engine, lubricate bearings and collar with WB 2 grease.

g. RECORD KEEPING. Enter all services performed on gasoline engine on WD AGO Form 5–34. It is recommended that forms be made out as follows:

(1) One card for *before-operation service* (par. 15*a*).

(2) One card for *during-operation service* (par. 15*b*).

(3) One card to include *short-stop service, after-operation service,* and *additional services* (par. 15*c, d,* and *e*).

(4) Two cards for *running test of engine and accessories,* one for items in paragraph 15*f*(1) through (16), and a second for items in paragraph 15*f*(17) through (33).

16. Belt Drives

a. GENERAL. Maintaining proper tension and alignment of belt drives insures long life of belts and sheaves. Incorrect alignment causes poor

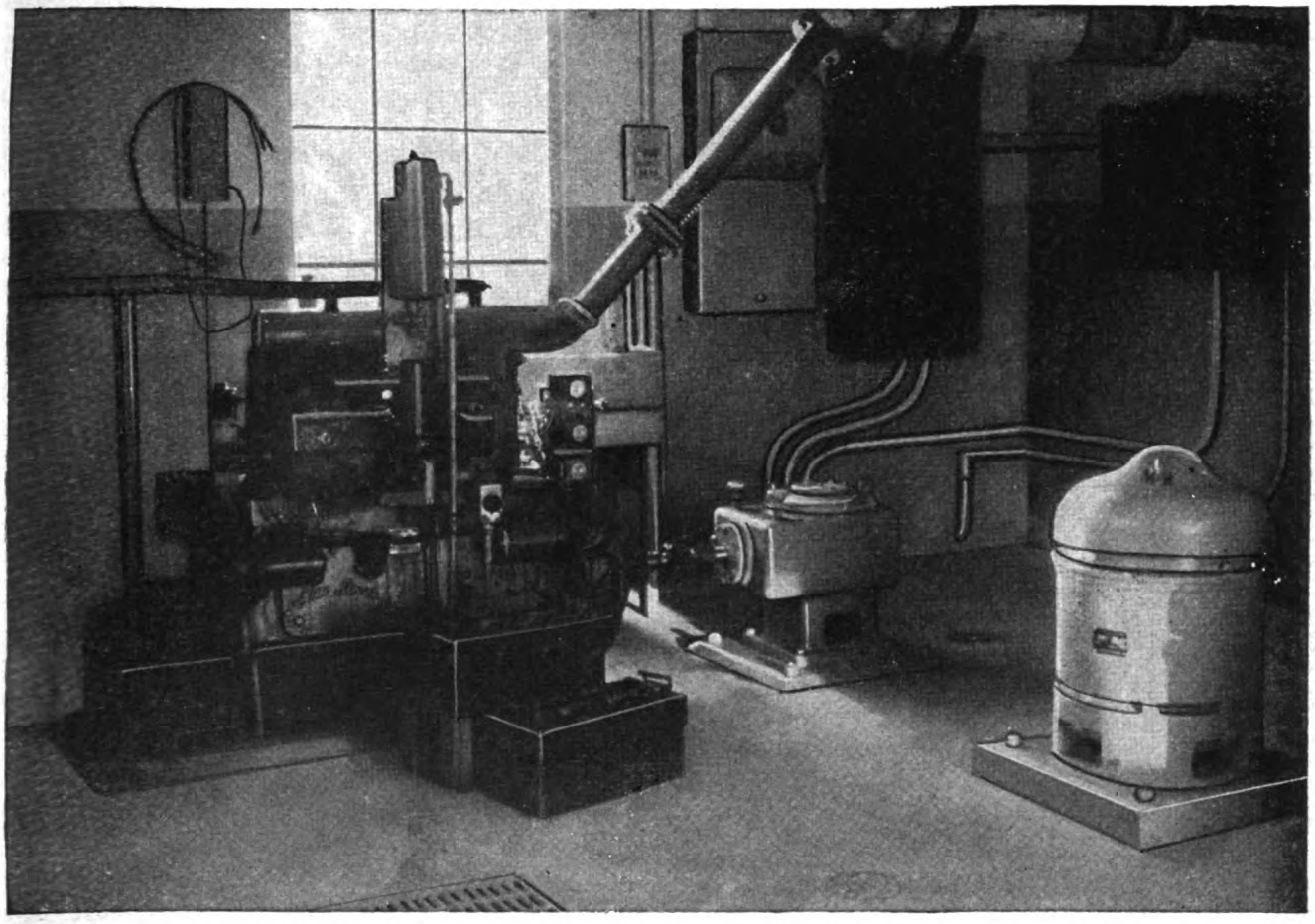

Figure 7. Gasoline engine with power take-off to sewage pump.

D	W	M	Q	S	A

operation and excessive belt wear. Inadequate tension reduces the belt grip, causes high belt loads, snapping, and unusual wear.

(1) *Cleaning belts.* Keep belts and sheaves clean and free of oil, which causes belts to deteriorate. To remove oil, take belts off sheaves and wipe belts and sheaves with a rag moistened in carbon tetrachloride.

(2) *Installing belts.* Before installing belts, replace worn or damaged sheaves, then slack off on adjustments. Do not try to force belts into position; never use a screw driver or similar lever to get belts onto sheaves. After belts are installed adjust tension; recheck tension after 8 hours of operation.

(3) *Replacing belts.* Replace belts as soon as they become frayed, worn, or cracked. NEVER REPLACE ONE V-BELT ON A MULTIPLE DRIVE. Replace the complete set with a set of matched belts, which can be obtained from any supplier. All belts in a matched set are machine-checked to insure equal size and tension.

(4) *Storing spare belts.* Store spare belts in a cool dark place. Tag all belts in storage to identify them with the equipment on which they can be used.

b. V-BELTS. A properly adjusted V-belt has a slight bow in the slack side when running; when idle it has an alive springiness when thumped with the hand. An improperly tightened belt feels dead when thumped. If the slack side of the drive is less than 45° from the horizontal, vertical sag at the center of the span may be adjusted in accordance with table VII below.

Table VII. Belt tension

Span (inches)		10	20	50	100	150	200
Vertical sag (inches)	From	.01	.03	.20	.80	1.80	3.30
	To	.03	.09	.58	2.30	4.90	8.60

2 (1) *Check tension.* If tightening belt to proper tension does not correct slipping. Check for overload, oil on belts, or other possible causes. Never use belt dressing to stop belt slippage. Rubber wearings near the drive are a sign of improper tension, incorrect alignment, or damaged sheaves.

3 (2) *Check sheave alignment.* Lay a long straightedge or string across outside faces of pulleys, and allow for differences in dimensions from center lines of grooves to outside pulley faces of the pulleys being aligned. Be especially careful in aligning drives with more than one V-belt on a sheave, as misalignment can cause unequal tension.

c. FLAT BELTS. Leather or rubber belts are usually used in flat-belt drives. Most flat-belt drives have either an adjustable idea or a pivoted-base drive motor to maintain belt tension.

1 (1) *Check operation and tension.* Check general operating conditions during regular tours of duty. Keep surroundings clean. Observe belt tension and adjust if necessary. Slapping and whipping are evidences of improper tension. If a rubber flat belt slips after tension has been properly adjusted, moisten pulley side of belt slightly with boiled linseed oil. To keep leather belts from slipping, use belt dressing type B, class 14 TPS, stock No. 14–B–155, available in stick form; never use rosin on leather belts.

4 (2) *Check alignment.* Check pulley alignment with straightedge or string and make necessary corrections.

D	W	M	Q	S	A
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				7	
				8	
				9	
				10	
				11	

17. Chain Drives

a. GENERAL. Chain drives may be designed for slow, medium, or high speeds.

(1) *Slow-speed drives.* Because slow-speed drives are not usually inclosed, adequate lubrication is difficult. Heavy oil applied to the outside of the chain seldom reaches the working parts; in addition, the oil catches dirt and grit and becomes abrasive. For lubricating and cleaning methods, see *e* and *f* below.

(2) *Medium- and high-speed drives.* Medium-speed drives should be continuously lubricated with a device similar to a sightfeed oiler. High-speed drives should be completely inclosed in an oiltight case and the oil maintained at proper level. Lubricate roller chains with NS 2075 or NS 3065.

b. CHECK OPERATION. Check general operating condition during regular tours of duty.

c. CHECK CHAIN SLACK. The correct amount of slack is essential to proper operation of chain drives. Unlike other belts, chain belts should not be tight around the sprocket; when chains are tight, working parts carry a much heavier load than necessary. Too much slack is also harmful; on long centers particularly, too much slack causes vibrations and chain whip reducing life of both chain and sprocket. A properly installed chain has a slight sag or looseness on the return run. Make sure a tightener is installed on the drive chain; if there is none, notify the post engineer.

d. CHECK ALIGNMENT. If sprockets are not in line or if shafts are not parallel, excessive sprocket and chain wear and early chain failure results. Wear on inside of chain, side walls, and sides of sprocket teeth are signs of misalignment. To check alignment, remove chain and place a straightedge against sides of sprocket teeth.

e. CLEAN. On inclosed types, flush chain and inclosure with kerosene. On exposed types, remove chain and soak and wash it in kerosene. Clean sprockets, install chain, and adjust tension.

Note. If chains are too large to soak them conveniently, wash them by applying gasoline with a brush.

f. CHECK LUBRICATION. Lubricate inclosed and exposed type chain drives as shown in table VI. Soak exposed type chains in CW 2 or in OE 30 oil to restore lubricating film. Remove excess lubricant by hanging chains up to drain.

Do not lubricate underwater chains which operate in contact with considerable grit. If water is clean, lubricate by applying WP or GG grease with brush while chain is running.

Do not lubricate chains on elevators or on conveyors of feeders which handle dirty or gritty materials. Dust and grit combine with lubricants to form a cutting compound which reduces chain life.

g. CHANGE OIL. On inclosed types only, drain oil and refill case to proper level.

h. INSPECT. Note and correct abnormal conditions before serious damage results. Do not put a new chain on old sprockets. Always replace sprockets when replacing a chain, because old, out-of-pitch sprockets cause as much chain wear in a few hours time as years of normal operation. Frequently, additional chain life can be secured by turning the chains over. Sprockets that are not too badly worn can be reversed on the shaft and the opposite surface of the tooth brought into use. Where the direction of rotation can

be changed without affecting operation of the driven equipment, the simple expedient of reversing electrical leads on the motor increases the life of chain drives appreciably.

i. TROUBLE SHOOTING. Some common symptoms of improper chain-drive operation and their remedies follow:

(1) *Excessive noise.* Correct alignment, if misaligned. Adjust centers for proper chain slack. Lubricate in accordance with aforementioned methods. Be sure all bolts are tight. If chain or sprockets are worn, reverse or renew if necessary.

(2) *Wear on chain, wide walls, and sides of teeth.* Remove chain and correct alignment.

(3) *Chain climbs sprockets.* Check for poorly fitting sprockets and replace if necessary. Make sure tightener is installed on drive chain.

(4) *Broken pins and rollers.* Check for chain speed which is too high for the pitch, and substitute chain with shorter pitch if necessary. Breakage may also be caused by shock loads.

(5) *Chain clings to sprockets.* Check for incorrect or worn sprockets or heavy, tacky lubricants. Replace sprockets or lubricants if necessary.

(6) *Chain whip.* Check for too-long centers or high pulsating loads and correct cause.

(7) *Chain gets stiff.* Check for misalignment, improper lubrication, or excessive overloads. Make necessary corrections or adjustments.

18. Variable-Speed Drives

82 *a. Clean disks.* Remove grease, acid, and water from disk faces.

83 *b. Check speed-change mechanism.* Shift drive through entire speed range to make sure shafts and bearings are lubricated and disks move freely in lateral direction on shafts.

84 *c.* CHECK V BELT. Make sure it runs level and true. If one side rides high a disk is sticking on shaft because of insufficient lubrication or wrong lubricant. In this case, stop the drive at once, remove V belt and clean disk hub and shaft thoroughly with kerosene until disk moves freely. Relubricate with soft ball-bearing grease and replace V belt in opposite direction from that in which it formerly ran.

86 If drive is not operated for 30 days or more, shift unit to minimum speed position, placing spring on variable-speed shaft at minimum tension and relieving belt of excessive pressure.

d. LUBRICATE DRIVE. Make sure to apply lubricant at all the six force-feed lubrication fittings (fig. 8: A, B, D, E, G and H), and the one cup type fitting (C), use BR grease.

Note. If the drive is used with a reducer, fitting E is not provided.

85 (1) Once every 10 days to 2 weeks, use two or three strokes of grease gun through fittings A and B at ends of shifting screw and variable-speed shaft, respectively, to lubricate bearings of movable disks. Then shift drive from one extreme-speed position to the other to insure thorough distribution of lubricant over disk-hub bearings.

87 (2) Add two or three shots of grease through fittings D and E to lubricate frame bearing on variable-speed shaft.

88 (3) Every 60 days add two or three cupfuls of grease to cup C which lubricates thrust bearing on constant-speed shaft.

89 (4) Every 60 days use two or three strokes of grease gun through fittings G and H to lubricate motor-frame bearings.

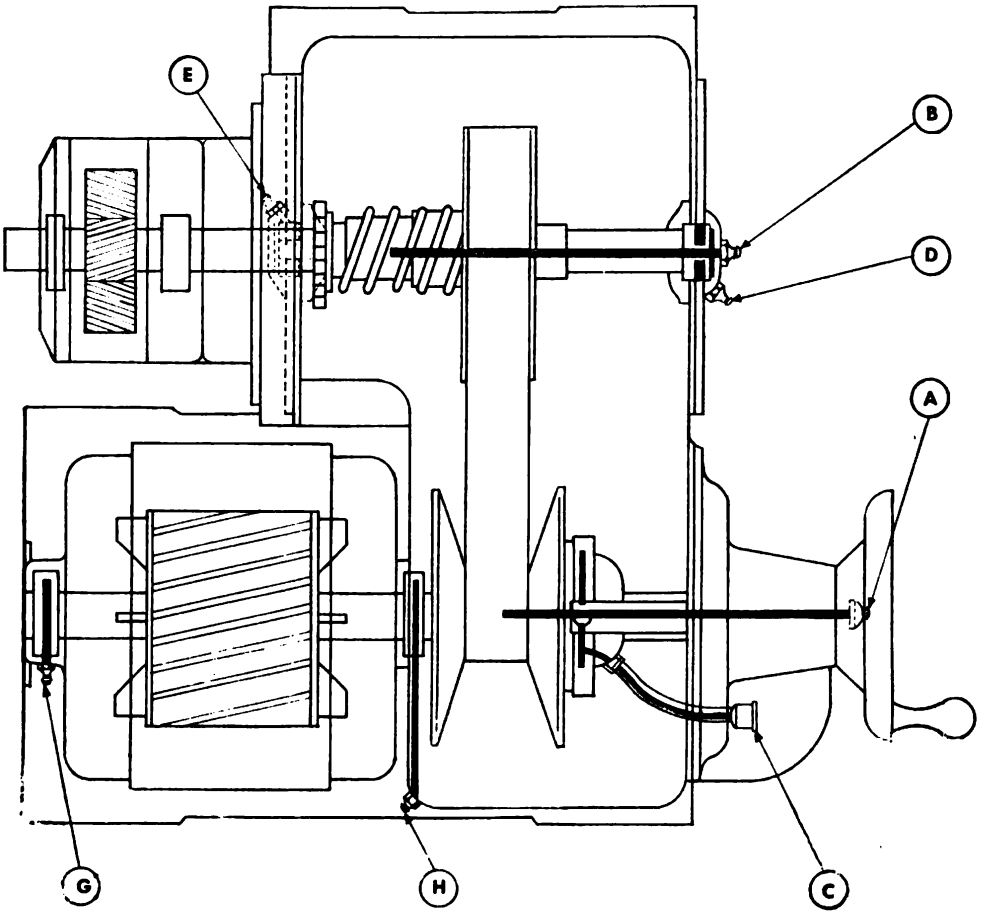


Figure 8. Reeves varidrive.

D	W	M	Q	S	A
			90		

Caution: **Do not use hard grease or grease containing graphite.**

e. LUBRICATE REDUCER. When unit leaves factory, gear reducer is without oil. Fill reducer case with oil described below until it drains out of oil plug. The reducer is provided with splash type self-lubrication and oil supply is replenished only when it gets low. Check oil level every 60 days by removing oil-hole plug. For temperatures of 0° F to 40° F use OE 30. For temperatures of 40° F to 100° F use NS 3080.

19. Couplings

a. GENERAL. Unless couplings between the driving and driven elements of a pump or any other piece of equipment are kept in proper alignment, breaking or excessive wear results in either or both the driven machinery and the driver. Burned-out bearings, sprung or broken shaft, and excessively worn or ruined gears are some of the damages caused by misalignment. To prevent outages and the expense of installing replacement parts, check the alignment of all equipment *before* damage occurs.

(1) Improper original installation of the equipment may not necessarily be the cause of the trouble. Settling of foundations, heavy floor loadings, warping of bases, excessive bearing wear, and many other factors cause misalignment. A rigid base is not always security against misalignment. The base may have been mounted off level, ~~which~~ would cause it to warp.

(2) Flexible couplings permit easy assembly of equipment, but they must be aligned as exactly as flanged couplings if maintenance and repair are to be kept to a minimum. Rubber-bushed types cannot function properly if the bolts cannot move to their bushings.

				12	

b. CHECK COUPLING ALIGNMENT. Excessive bearing and motor temperatures caused by overload, noticeable vibration or unusual noises may all be warnings of misalignment. Realign when necessary, using a straightedge and thickness gauge or wedge. To insure satisfactory operation, level up to within 0.005 inch as follows:

(1) Remove coupling pins.

(2) Rigidly tighten driven equipment; slightly tighten bolts holding drive.

(3) To correct horizontal and vertical misalignment, shift or shim drive to bring coupling halves into position so no light can be seen under a straightedge laid across them. Place straightedge in four positions, holding a light back of straightedge to help insure accuracy.

(4) Check for angular misalignment with a thickness or feeler gauge inserted at four places to make certain space between coupling halves is equal.

(5) If proper alignment has been secured, coupling pins can be put in place easily using only finger pressure. *Never hammer pins into place.*

(6) If equipment is still out of alignment repeat the procedure.

					13

c. CHANGE OIL IN FAST COUPLINGS. Drain out old oil and add gear oil to proper level. Correct quantity is given on instruction card supplied with each coupling.

20. Shear Pins

Many water-treatment units have shear pins, protective devices to prevent damage in case of sudden overloads. To serve their purpose these devices must be in condition to operate at all times. Under unfavorable

D	W	M	Q	S	A

operating conditions shearing surfaces of a shear-pin device may freeze together so solidly that an overload fails to break them.

Manufacturer's drawings for particular installations usually specify shear-pin material and size. If not, obtain the information from the manufacturer, giving him model, serial number, and load conditions of unit. When necessary to determine shear-pin size quickly, select the lowest strength which does not break under unit's usual loads. When proper size is determined never use a pin of greater strength, a bolt, or a nail. If necked pins are used, be sure necked-down portion is properly positioned with respect to shearing surfaces. When a shear pin breaks, determine and remedy cause of failure before inserting new pin and starting drive in operation.

14 *a.* GREASE SHEARING SURFACES. Use WB 2 grease or OE 30.

15 *b.* REMOVE SHEAR PIN. Operate motor for a short time to smooth out any corroded spots.

16 *c.* CHECK SPARE-PIN INVENTORY. Make sure an adequate supply is on hand, properly identified and with record of proper pin size, necked diameter, and longitudinal dimensions.

SECTION V

HORIZONTAL AND VERTICAL SEWAGE PUMPS

D	W	M	Q	S	A

21. General

Detailed maintenance procedure for several makes and types of pumps are given in paragraphs below. Because all makes and types cannot be included, this paragraph lists some general preventive maintenance services and indicates frequency of performance. Typical pump sections are shown in figures 9 and 10.

1 — *a.* CHECK WATER-SEAL PACKING GLANDS FOR LEAKAGE. See that packing box is protected with a clear-water supply from an outside source, making sure that pressure at water-seal-valve entrance point is not less than pump-shutoff head. See that there are no cross connections. Check packing glands for leakage during operation. Allow a slight seal leakage when pumps are running to keep packing cool and in good condition. Proper amount of leakage depends on equipment and operating conditions. If excessive leakage is found, tighten gland nuts evenly, but not too tight. After adjusting packing glands, be sure shaft turns freely by hand. If serious leakage continues, renew packing, shaft, or shaft sleeve.

2 — *b.* CHECK GREASE-SEALED PACKING GLANDS. When grease is used as a packing-gland seal, maintain constant grease pressure on packing during operation. When a spring-loaded grease cup is used, keep it loaded with WP grease. Force grease through packing at rate of about 1 ounce per day.

3 — *c.* OPERATE PUMPS ALTERNATELY. If two or more pumps of same size are installed, alternate their use to equalize wear, keep motor windings dry, and distribute lubricant in bearings.

4 — *d.* INSPECT PUMP ASSEMBLY. (1) Check float controls, noting how they respond to rising water level. See that unit starts when float switch makes contact and that pump empties basin at normal rate. Apply light oil to moving parts.

(2) Service stand-by pump and run assembly long enough to obtain normal motor-temperature rise.

* — *e.* CHECK MOTOR CONDITION. See paragraph 14.

5 — *f.* CLEAN PUMP. Clean-out manholes are provided on the pump volute. To clean pump, close all valves, drain pump, remove handhole cover, and remove all solids.

6 — *g.* CHECK PACKING-GLAND ASSEMBLY. Check packing gland, the unit's most abused and troublesome part. If stuffing box leaks excessively when gland is pulled up with mild pressure, remove packing and examine shaft sleeve carefully. Replace grooved or scored shaft sleeve because packing cannot be held in stuffing box with roughened shaft or shaft sleeve. Re-

Abbreviations: D, means daily; W, weekly; M, monthly; Q, quarterly; S, semiannually; A, annually.

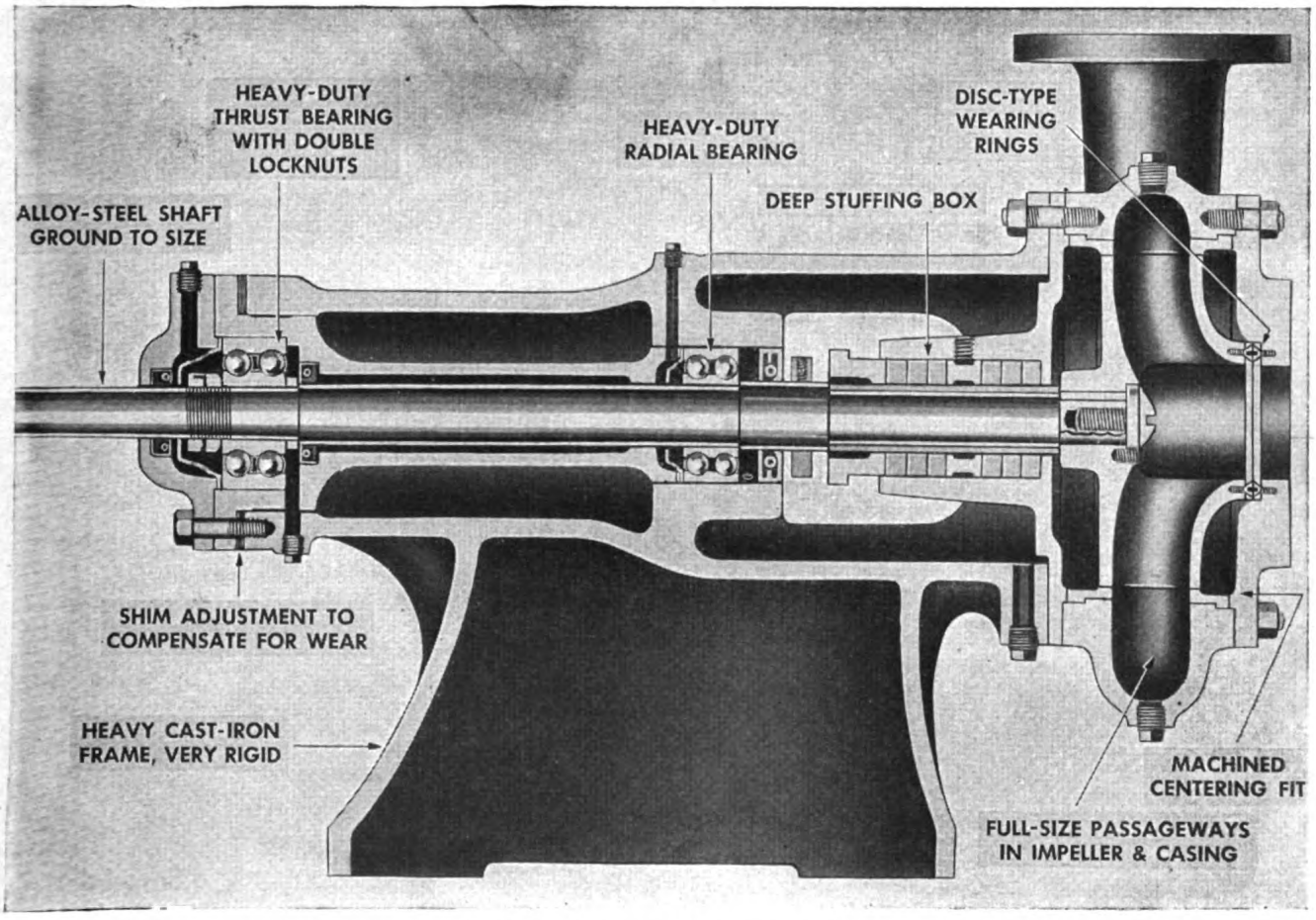


Figure 9. Horizontal sewage pump.

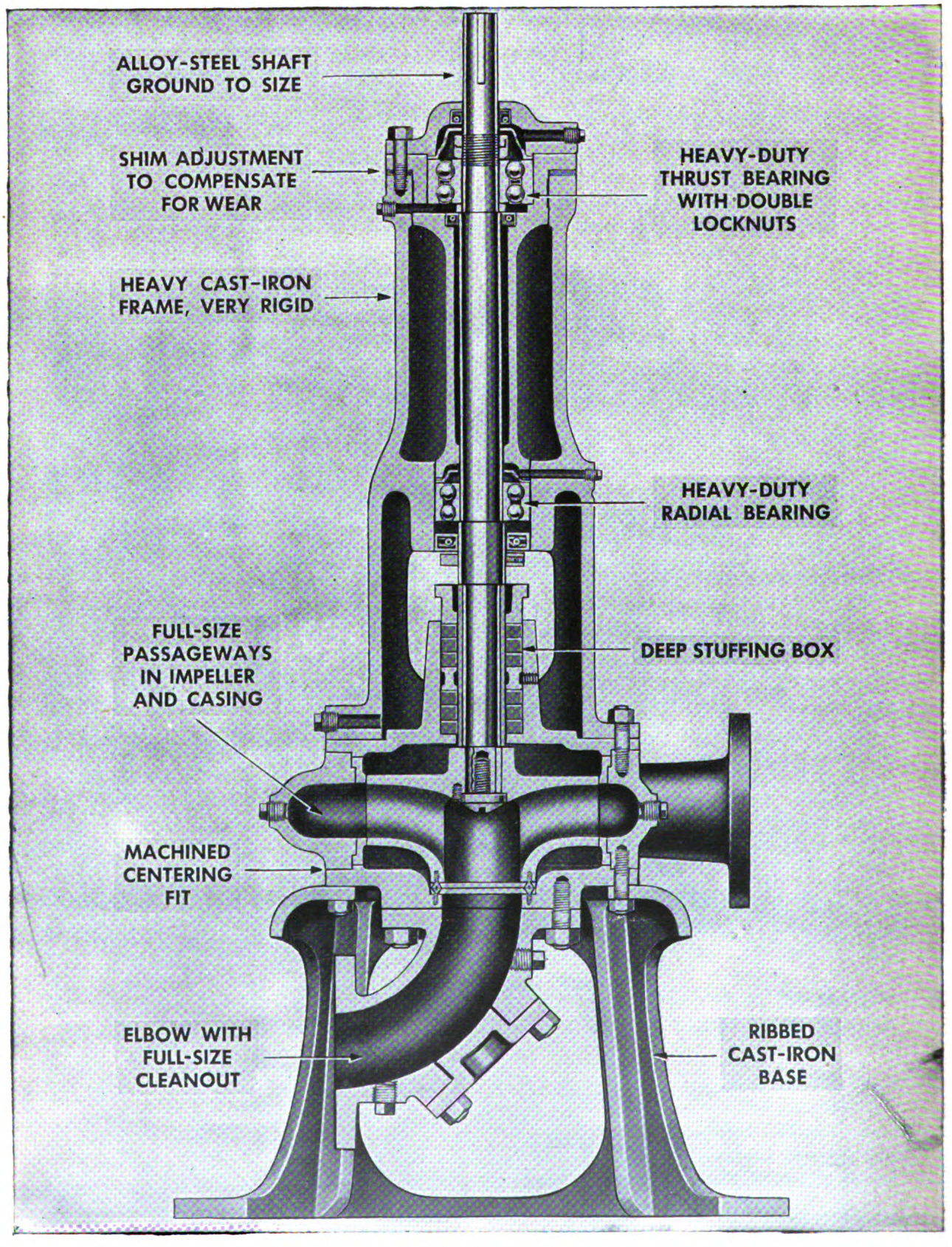


Figure 10. Vertical ball-bearing type sewage pump.

D	W	M	Q	S	A

place the packing a strip at a time, tamping each strip thoroughly and staggering joints. (See fig. 11.) Position lantern ring properly. If grease sealing is used, completely fill lantern ring with grease before putting remaining rings of packing in place. The type of packing used is less important than manner in which packing is placed. However, never use a continuous strip of packing. This type packing wraps around and scores the shaft sleeve or is thrown out against outer wall of stuffing box, allowing sewage to leak through and score the shaft.

7

h. INSPECT AND LUBRICATE BEARINGS. Unless otherwise specifically directed for a particular pump model, drain lubricant and wash out oil wells and bearing with kerosene. Check sleeve bearings to see that oil rings turn freely with the shaft. Repair or replace if defective. Refill with proper lubricant. (See par. 7 and table V.)

Measure bearings and replace those worn excessively. Generally, allow clearance of 0.002 inch plus 0.001 inch for each inch or fraction of inch of shaft-journal diameter.

8

i. CHECK OPERATING TEMPERATURE OF BEARINGS. Check bearing temperature with thermometer, not by hand. If antifriction bearings are running hot, check for over-lubrication and relieve if necessary. If sleeve bearings run too hot, check for lack of lubricant. If proper lubrication does not correct condition, disassemble and inspect bearing. Check alignment of pump and motor if high temperatures continue.

9

j. CHECK ALIGNMENT OF PUMP AND MOTOR. For method of aligning pump and motor, see paragraph 19. If misalignment recurs frequently, inspect entire piping system. Unbolt piping at suction and discharge nozzles to see if it springs away, indicating strain on casing. Check all piping supports for soundness and effective support of load.

Vertical pumps usually have flexible shafting which permits slight angular misalignment; however, if solid shafting is used, align exactly. If beams carrying intermediate bearings are too light or are subject to contraction or expansion, replace beams and realign intermediate bearings carefully.

10

k. INSPECT AND SERVICE PUMPS. (1) Remove rotating element of pump and inspect thoroughly for wear. Order replacement parts where necessary.

(2) Remove any deposit or scaling. Clean out water-seal piping.

(3) Determine pump capacity by pumping into empty tank of known size or by timing the draining of pit or sump.

(4) Test efficiency pump. If possible compare kilowatt-hour with total foot-pounds of work performed.

(5) Measure total dynamic suction and discharge lifts to test pump and pipe condition. Record figures for comparison with later tests.

(6) Inspect foot and check valves, paying particular attention to check valves, which can cause water hammer when pump stops. (See also par. 40.)

(7) Examine wearing rings. Replace seriously worn wearing rings to improve efficiency. Check wearing ring clearances which generally should be no more than 0.003 inch per inch of wearing-ring diameter.

Caution: To protect wearing rings and casing, never allow pump to run dry through lack of proper priming when starting or loss of suction when operating.

D	W	M	Q	S	A
					*
†					
11					
12					

l. DRAIN PUMP BEFORE PROTRACTED SHUT-DOWN. When shutting down pump for a long period, open motor-disconnect switch; shut all valves on suction, discharge, water-seal, and priming lines; drain pump completely by removing vent and drain plugs. This procedure protects pump against corrosion, sedimentation, and freezing. Inspect pump and bearings thoroughly and perform all necessary servicing. Drain bearing housings and replenish with fresh oil, or purge of old grease and replace. Resume periodic checks after pump is put back in service.

22. Aurora Pumps (MSM, NSA, KS, KU, and KGG Types)

a. PERFORM GENERAL PUMP MAINTENANCE. See paragraph 21 *a, b, c, d, e, f, h, i,* and *j*.

b. CHECK HAND-OILER SETTINGS. If hand oiler is used for oiling shaft bearings, check setting as follows:

(1) For pumps operating once a month to twice a day, running time not over 5 minutes: 1 drop every 15 minutes.

(2) For pumps operating 3 to 12 times a day, running time not over 5 minutes: 1 drop every 4 minutes.

(3) For pumps operating up to 50 times a day, running time not over 5 minutes: 1 drop every 2 minutes.

(4) Above 50 times a day: 2 to 4 drops per minute.

c. CHECK OPERATION OF SOLENOID OILER. If solenoid oiler is used, connect solenoid leads so solenoid is energized as soon as switch is closed, thus raising needle valve and allowing oiler to function. If no oil flow from lubricator after current is turned on, inspect needle valve for foreign

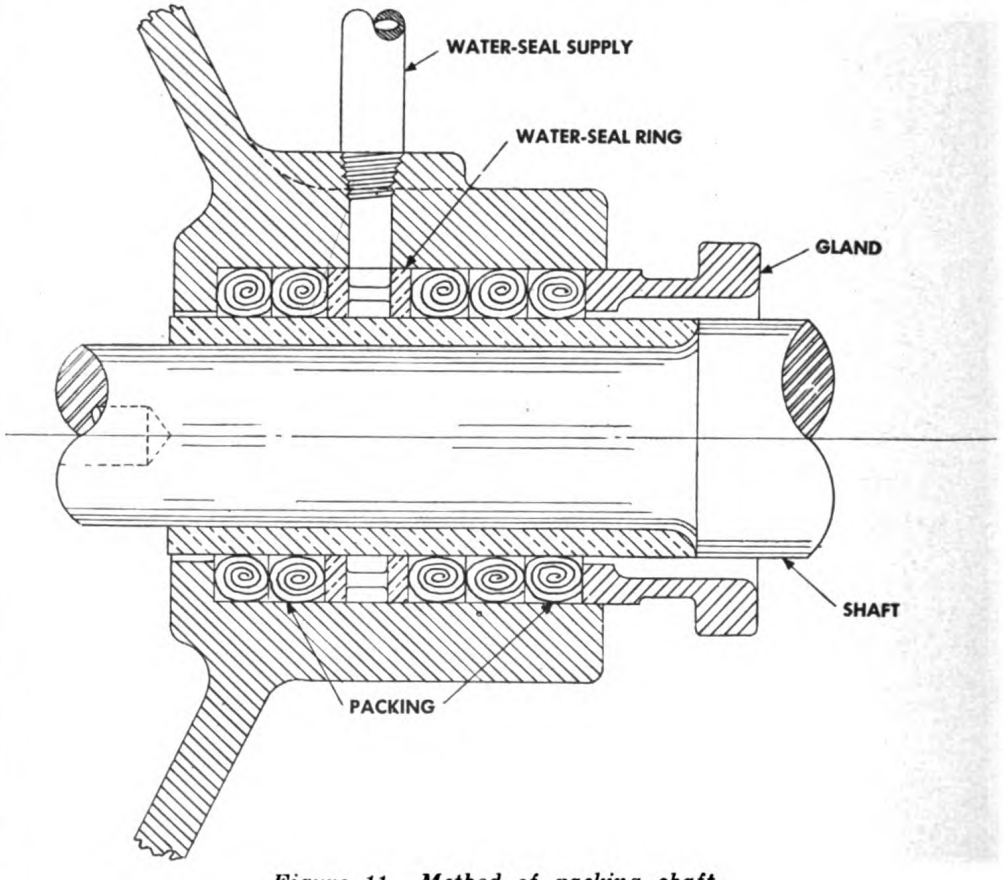


Figure 11. Method of packing shaft.

D	W	M	Q	S	A

matter in opening. Set oiler at 2 to 4 drops per minute, using OE 10 or NS 3050.

Q 14 — *d.* LUBRICATE BALL THRUST BEARING. Lubricate ball thrust bearing by grease cup in base of motor base. If pump operates oftener than 50 times daily, change grease quarterly; otherwise change annually.

M 13 — *e.* SERVICE GREASE CUPS. Fill grease cup with fresh BR grease. Do not try to keep grease from coming out around ball-bearing collar seal when servicing and when pump is operating. Design of bearing housing includes this feature to prevent packing the ball bearing and causing overheating.

Q 15 — *f.* SERVICE AND GREASE BALL BEARINGS. (1) *Clean and lubricate.* Clean ball bearings and lubricate with BR grease. Frequency depends on type of installation and individual service conditions.

Caution: If bearings overheat, do *not* add grease. Too much lubricant, not too little, may be the cause. If lubrication is correct, check carefully for other possible causes.

(2) *Flush bearing housing.* Open bearing housing, flush with clean kerosene, and refill with new, clean grease. Since foreign solids or liquids in housing ruin bearings quickly, keep housing immaculately clean and never refill with used grease.

23. Chicago Pumps (General and Ball-Bearing Types)

a. PERFORM GENERAL PUMP MAINTENANCE. See paragraph 21 *a*, *f*, and *h*.

Q 19 — *b.* CHECK COUPLING CONNECTIONS. See paragraph 19.

W 17 — *c.* CHECK BELT-DRIVEN UNITS. Maintain adjustment and alignment of belt-driven units. Replace worn belts. When V belt drives are used, make sure sheaves are in perfect alignment because slight variation causes excessive belt wear.

Q 18 — *d.* SERVICE PUMP PACKING BOX. Remove packing nuts and glands. Pick out old packing, and remove lantern or water-seal ring, if present. Clean box and shaft thoroughly. Cut rings of packing, making ends square so butts just meet around shaft. Dip each ring in heavy oil and graphite before inserting in packing box. In replacing gland, see that followers enter packing box at least ⅛ inch to prevent rocking of glands; see that followers do not jam or touch shaft.

D 16 — *e.* CHECK LUBRICATING-OIL LEVEL IN BALL-BEARING TYPES. Make sure oil well in bearing housing is always filled to just below overflow point of filling cup or oil plug. Lubricate with NS 3050 or OE 30. When adding oil, remove oil-vent plug in top of bearing housing.

Caution: Do not oil housing while pump shaft is rotating because rotating ball bearings pick up oil which subsequently drains down, overflowing around shaft or out of oil cup.

24. Chicago Vertical Pumps (Open and Inclosed Shafts)

a. OPEN-SHAFT TYPE. Perform the following services on open-shaft Chicago vertical pumps (fig. 12):

† — (1) *Perform general pump maintenance.* See paragraph 21 *a*, *b*, *c*, *d*, *e*, *f*, *h*, *i*, *j*, and *k*.

M 21 — (2) *Lubricate ball bearings.* Lubricate the two ball bearings separately through Zerk or Alemite fittings on housing or through extension grease lines. Use BR grease.

Q 24 — (3) *Lubricate guide bearings.* Lubricate guide bearings with BR grease, added through Zerk or Alemite fittings.

D	W	M	Q	S	A
				25	
†					
	20				
		22			
		23			
			18		
†					
	20				
		27			
		23			
			18		
					29
26					
	21				
2					
		28			
				25	
	26				
†					
30					

(4) *Lubricate universal-joint couplings.* Lubricate universal-joint bearings and slip splines with BR grease, added through Zerk or Alemite fittings.

b. INCLOSED-SHAFT TYPE. Service inclosed-shaft Chicago vertical pumps as follows:

(1) *Perform general pump maintenance.* See paragraph 21 *b, c, h, i, j,* and *k.*

(2) *Lubricate thrust bearings.* Before operating pump, fill thrust-bearing oil cup with OE 30 or NS 3080. Increase frequency if operating conditions require it.

(3) *Lubricate guide bearings.* Lubricate standard units through Zerk or Alemite high-pressure grease fittings located on floor plate under motor pedestal. Use BR grease.

(4) *Lubricate float-rod packing washer.* Put a few drops of OE 10 on float-rod packing washer at foot of float-switch stand.

(5) *Service pump packing box.* See paragraph 23*d.*

25. Chicago Pumps (Flush-Kleen Types)

a. INCLOSED-SHAFT TYPES A, C, F, AND H. Service inclosed-shaft Chicago pumps, types A, C, F and H as follows:

(1) *Perform general pump maintenance.* See paragraph 21 *a, b, e, f, i, j,* and *k.*

(2) *Lubricate thrust bearings.* See paragraph 24*b* (2).

(3) *Lubricate guide bearings.* Lubricate standard units through Zerk or Alemite high-pressure grease fittings on floor plates under motor pedestals. Use CG O Grease.

(4) *Lubricate float-rod packing washer.* See paragraph 24*b* (4).

(5) *Check packing-gland assembly.* See paragraph 23*d.*

(6) *Inspect strainers and valves.* Check strainers for cleanliness and valves for mechanical condition.

(7) *Check float switches.* Because pumps do not operate unless float switches are closed, check switches when starting and stopping pump. Normally, only one pump operates at a time, operation being automatically transferred from pump to pump by the mechanical alternator. When short-circuiting switches are used, pumps may be run independently of float controls by moving switches to *on* position.

b. OPEN-SHAFT TYPE O. Perform following maintenance on open-shaft Chicago pumps, type O.

(1) *Lubricate ball bearings.* See paragraph 24*a* (2).

(2) *Lubricate grease seals.* See paragraph 21*b.*

(3) *Lubricate guide bearings.* Lubricate guide bearings CG O grease, added through the Zerk or Alemite fittings.

(4) *Lubricate universal-joint couplings.* See paragraph 24*a* (4).

(5) *Check float switches.* See paragraph 25*a* (7).

26. Chicago Pumps (VCSOS–3 and VCSOSC–4 Types)

a. PERFORM GENERAL PUMP MAINTENANCE. See paragraph 21 *c, d, e, f, g, i, j,* and *k.*

b. LUBRICATE THRUST BEARINGS. Before running pump, fill thrust-bearing oil cup with OE 30 on NS 3080. Keep oil level at about ⅛ inch from top of cup.

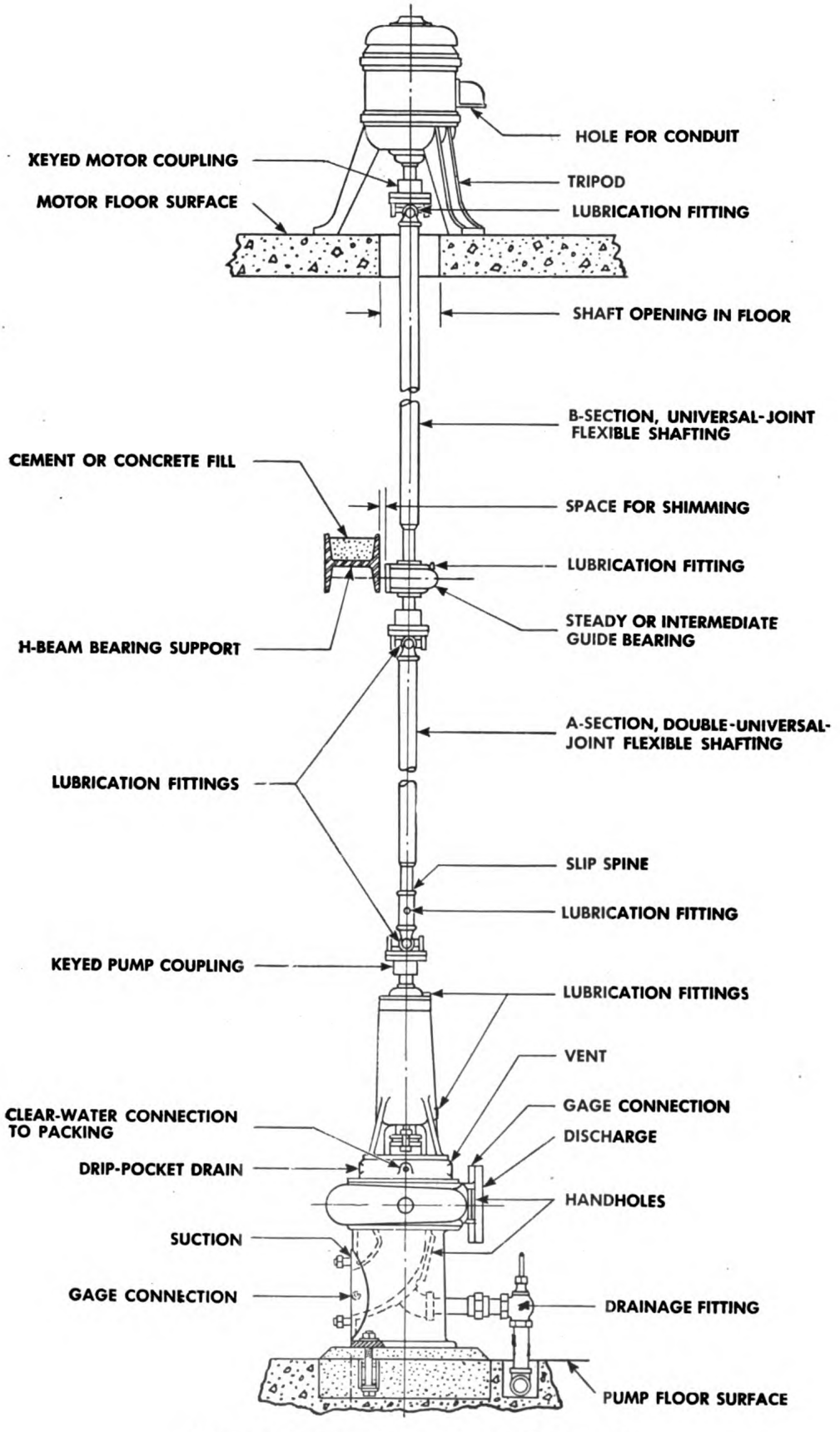


Figure 12. Typical vertical open-shaft pump.

c. FLUSH THRUST BEARINGS. Drain thrust-bearing oil well by removing drain plug in oil line just below oil cup. Flush with kerosene on fresh oil and refill with new oil.

d. LUBRICATE GUIDE BEARINGS. Before starting pump and quarterly thereafter, add CG O grease through Zerk or Alemite fittings located on floor plate under motor pedestal.

e. LUBRICATE FLOAT-ROD PACKING WASHER. See paragraph 24*b* (4).

f. CHECK PACKING-GLAND ASSEMBLY. See paragraphs 21*a* and 23*g*.

27. Chicago Scru-Peller Pumps (Sewage or Sludge Types)

a. PERFORM GENERAL PUMP MAINTENANCE. See paragraph 21 *b*, *d*, *e*, *f*, *g*, *h*, *i*, *j*, and *k*.

b. LUBRICATE BEARING AND FILTERS. Lubricate sludge pump by filling the two oil cups on bearing housings with OE 30 or NS 3080. Oil passes through wick filters before reaching bearings.

c. REPLACE FILTERS. Remove outer bearing-retaining plate and outer thrust plate. Pull out old wicking and replace with new lengths.

d. REFILL BEARING HOUSING. Open housing, flush out with kerosene, and drain. Refill with new oil making sure shaft is stationary. If it is revolving, bearings pick up oil which sinks when pump stops, causing overlubrication. Keep oil level below low side of shaft. Check for over-lubrication when oil overflows around shaft.

e. LUBRICATE VARIDRIVE. See paragraph 18.

f. CHECK PACKING-GLAND LEAKAGE. When water seals are used, permit about 60 drops per minute water leakage from packing boxes when pump is running, to keep packing cool and in good condition. If leakage is serious, tighten the two gland nuts evenly, but not too tight. After adjusting packing glands, see that shaft turns freely by hand.

g. CLEAN FLOAT MECHANISM. When automatic priming equipment is used on sludge installations, be particularly careful to keep float mechanism clean.

28. Delaval-Type Pumps

a. PERFORM GENERAL PUMP MAINTENANCE. See paragraph 21 *a*, *c*, *d*, *e*, *f*, *g*, *i*, *j*, and *k*.

b. RENEW GREASE IN BEARINGS. Remove drain plug in bearing housing and inject fresh grease through grease-gun connection until all old grease is forced out through drain. Before replacing drain plug, operate pump for a few minutes until excess grease works way out of housing. Too much grease causes overheating.

29. Fairbanks-Morse Pumps (5410, 5420, and 5330 Types)

a. PERFORM GENERAL PUMP MAINTENANCE. See paragraph 21 *c*, *d*, *e*, *f*, *g*, *i*, *j*, and *k*.

b. LUBRICATE BEARINGS. Procedure for lubricating bearings on Fairbanks-Morse pumps is given below. Increase frequency of lubrication for special installations or unusually severe service conditions.

(1) *Flushing.* Bearings must be flushed out before new grease is added.

(*a*) Wipe housing clean, remove upper plug in bearing housing, and pour in a small amount of alcohol, spindle oil, flushing oil, or carbon tetrachloride. Kerosene may be used in emergency. Replace upper plug

D | W | M | Q | S | A

and run pump a few minutes. Stop pump, remove lower plug, and allow bearing to drain. If carbon tetrachloride is used, follow it with a flushing oil.

(*b*) Remove housing and inspect bearing and housing for freedom from old grease and flushing oil to prevent dilution of new grease. Repeat flushing if necessary. See that no dirt or grit gets into bearing at any time.

(2) *Refilling.* With pump shaft rotating, refill bearing through filler openings. This insures thorough distribution of grease around bearing. For approximate weight of grease needed to refill pump bearing housings see table VI.

Note. A slight rattle in the bearing is a sign that lubricant has leaked out and bearing is dry. If rattle is heard, stop pump immediately and examine bearing carefully. If no damage is found, refill with BR grease and start pump. Observe operation closely until certain bearing is functioning properly.

Table VI. Bearing lubrication

Pump type	Pump size (in inches)	Frame No.	Ounces of grease required	
			Opposite drive end	Drive end
5410	—	1	5	10
5410	—	2	5	10
5410	—	3	19	38
5410	—	4	28	57
5410	—	5	47	95
5410	10	—	51	63
5410	12	—	152	114
5410	14	—	190	228
5420	—	1	4	11
5420	—	2	1.75	3.5
5420	—	3	2	3.5
5420	—	4	19	28
5420	—	5	43	19
5420	10-12	A	43	19
5420	12-14	B	200	120
5530	—	1	5	10
5530	—	2	5.25	10

1 *c.* CHECK WATER-SEAL LEAKAGE. See paragraph 21*a*. Make sure pumps which are fitted with water-sealed stuffing boxes have packing on both sides of water-seal ring.

39 *d.* CHECK IMPELLER CLEARANCE. Adjust clearance to meet manufacturer's recommendations.

30. Gardner-Denver Pumps (Type K)

† *a.* PERFORM GENERAL MAINTENANCE. See paragraph 21 *a, b, c, d, e, f, g, h, i, j,* and *k.*

40 *b.* LUBRICATE BEARINGS. Use 1 teaspoonful of BR grease or any standard vaseline. Lubricate quarterly or semiannually depending on type of service and installation.

31. Chicago Sump and Bilge Pumps

a. TYPES L–1, L–1B, L–1C, AND L–1D. Maintain types L–1, L–1B, and L–1C Chicago sump pumps and type L–1D Chicago bilge pumps as follows:

† (1) *Perform general pump maintenance.* See paragraph 21 *c, d, e, g, i, j,* and *k.*

41 (2) *Lubricate bearings.* Fill oil cups leaving guide bearings and thrust

D	W	M	Q	S	A
				45	
		43			
†					
	42				
		44			

bearing with OE 30 or NS 3080 to within about ⅛ inch of top of cup.

(3) *Thrust-bearing well.* Remove drain plug in oil line just below cup. Flush with kerosene, or OE 10 and refill with new lubricant.

(4) *Inspect and clean basin.* Run pump until basin is drained of water; inspect basin for accumulated sludge or solid material and check strainer for clogging. Clean basin thoroughly, removing the pump from basin if necessary.

b. TYPES LG–2 AND LGL–2. Service types LG–2 and LGL–2. Chicago bilge pumps as follows:

(1) *Perform general pump maintenance.* See paragraph 21 *c, d, e, g, i, j,* and *k.*

(2) *Lubricate bearings.* Turn down grease cup on floor of motor pedestal two or three turns to lubricate thrust bearing and upper bronze guide bearing. Before starting pump, give cup a half turn. When charge in grease cup becomes low, refill cup with WB 2 grease.

Lubrication for intermediate and discharge-casing bearing is provided for in pump design. Intermediate bearing has lifetime charge of lubricant in pump leg; discharge bearing is water-lubricated.

(3) *Clean basin.* Run pump until basin is drained of water. Break electrical circuit, disconnect the discharge pipe at union, and pull unit out of basin. If unit is floor-plate type, remove anchor bolts. Clean out sludge or foreign matter in basin and on strainer before returning pump to service.

SECTION VI

RECIPROCATING SLUDGE PUMPS

D	W	M	Q	S	A

32. General

The general procedures in this paragraph apply to all reciprocating sludge pumps described in this section and to many types used at Army posts.

a. CHECK SHEAR-PIN ADJUSTMENT. Set eccentric by placing shear pin (8d or 10d nail) through proper hole in eccentric flanges to give required stroke. Tighten the two 5/8- or 7/8-inch hexagonal nuts on eccentric flanges just enough to take spring out of lock washers. (See par. 20.) When shear pin fails, eccentric moves toward neutral position, preventing damage to the pump. Remove cause of obstruction and insert new shear pin. Shear pins fail because of one of three common causes:

(1) Solid object lodged under piston.
(2) Clogged discharge line.
(3) Stuck or wedged valve.

b. CHECK PACKING ADJUSTMENT. Give special attention to packing adjustment. If packing is too tight, it reduces efficiency and scores piston walls. Keep packing just tight enough to keep sludge from leaking through gland. Before pump is installed or after it has been idle for a time, loosen all nuts on packing gland. Run pump with sludge suction line closed and valve covers open for a few minutes to break in the packing. Turn down gland nuts no more than necessary to prevent sludge from getting past packing. Tighten all packing nuts uniformly.

When packing-gland bolts cannot be taken up farther, replace packing. Remove old packing and thoroughly clean cylinder and piston walls. Place new packing into cylinder, staggering packing-ring joints, and tamp each ring into place. Break in and adjust packing as explained above. When chevron type packing is used, tighten gland nuts only finger tight because excessive pressure ruins packing and scores plunger.

c. CHECK BALL VALVES. When valve balls are so worn that diameter is 1/2-inch smaller than original size, they may jam into guides in valve chamber. Check size of valve balls and replace if badly worn.

d. CHECK VALVE-CHAMBER GASKETS. Valve-chamber gaskets on most pumps serve as a safety device and blow out under excessive pressure. Check gaskets and replace if necessary. Keep additional gaskets on hand for replacement.

e. CHECK ECCENTRIC ADJUSTMENT. To take up babbitt bearing, remove brass shims provided on eccentric strap. After removing shims, operate pump for at least 1 hour and check to see that eccentric does not run hot.

f. NOTE UNUSUAL NOISES. Check for noticeable water hammer when pump is operating. This noise is most pronounced when pumping water or very thin sludge; it decreases or disappears when pumping heavy

Abbreviations: D, means daily; W, weekly; M, monthly; Q, quarterly; S, semiannually; A, annually.

D	W	M	Q	S	A

sludge. Eliminate noise by opening the ¼-inch pet-cock on pump body slightly; this draws in a small amount of air, keeping discharge air chamber full at all times.

3 *g.* CHECK CONTROL-VALVE POSITIONS. Because any plunger pump may be damaged if operated against closed valves in the pipe line, especially the discharge line, make all valve-setting changes with pump shut-down; otherwise pumps which are installed to pump from two sources or to deliver to separate tanks at different times may be broken if all discharge-line valves are closed simultaneously for a few seconds or discharge valve directly above pump is closed.

† *h.* SERVICE ELECTRIC MOTOR. See paragraph 14.

33. Barnes-Dorrco Type Pumps (fig 13)

† *a.* PERFORM GENERAL PUMP MAINTENANCE. See paragraph 32.

8 *b.* LUBRICATE BEARINGS. Apply CG 1 grease to all bearings at least once per shift or oftener if pump runs constantly for long periods. Use pressure gun and add grease at all buttonhead fittings.

10 *c.* LUBRICATE GEAR TRANSMISSION. Keep transmission filled to proper level with NS 6135 oil in summer and NS 3080 in winter.

11 Change oil to prevent sludging.

9 *d.* LUBRICATE PACKING. Keep sight-feed oil cup between plunger and stuffing box filled with NS 4065. One filling should last for 10 hours' operation. Squirt oil around plunger frequently.

34. Carter-Type Pumps

† *a.* PERFORM GENERAL PUMP MAINTENANCE. See paragraph 32.

11 14 18 *b.* LUBRICATE GEAR MOTOR. Follow closely factory instructions attached to gear motor; see also paragraph 14.

15 *c.* CHECK CHAIN DRIVE. Keep roller-chain drive clean and lubricated with OE 30.

16 *d.* CHECK MAIN BEARINGS. All main bearings are totally enclosed. Lubricate them with CG 1 grease.

12 *e.* CHECK ECCENTRIC BEARINGS. Set sight-feed oilers on eccentric bearings to deliver 1 drop of oil every 1 or 2 minutes and check to see that oil is feeding before pump is put into operation. Use NS 3065. Turn off oil feeders when pump is not operating.

17 *f.* CHECK CROSS-HEAD BEARING. Lubricate cross-head bearing at bottom of plunger with OE 30, filling plunger to cover the pin.

3 *g.* CHECK PLUNGER PACKING. Plunger is packed with graphite packing which provides enough lubrication under normal operation. When necessary, add NS 4065. After pump has been out of service, flood reservoir on top of packing gland with OE 30.

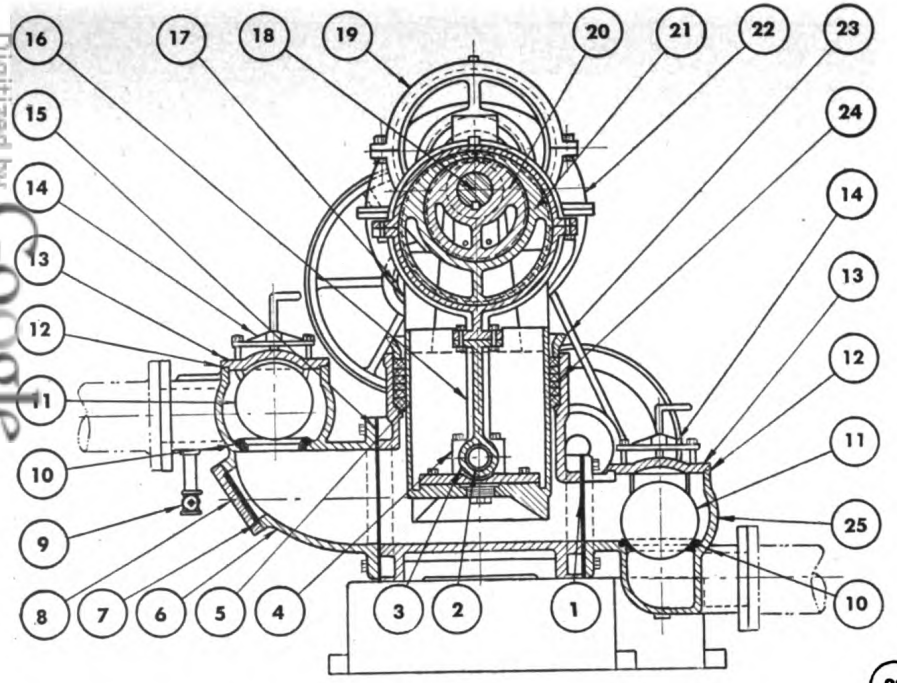
35. Chicago Plunger Type Pumps

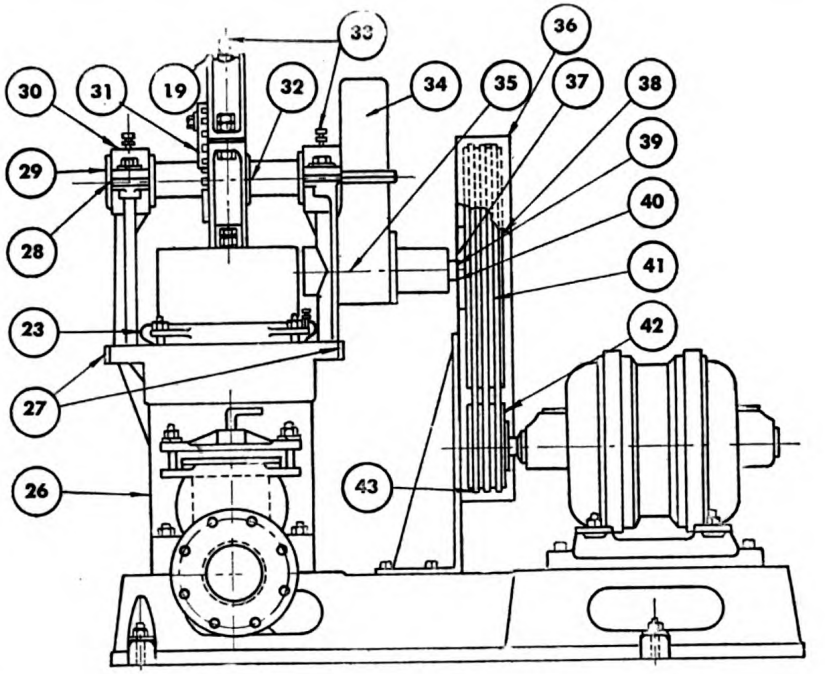
† *a.* PERFORM GENERAL PUMP MAINTENANCE. See paragraph 32.

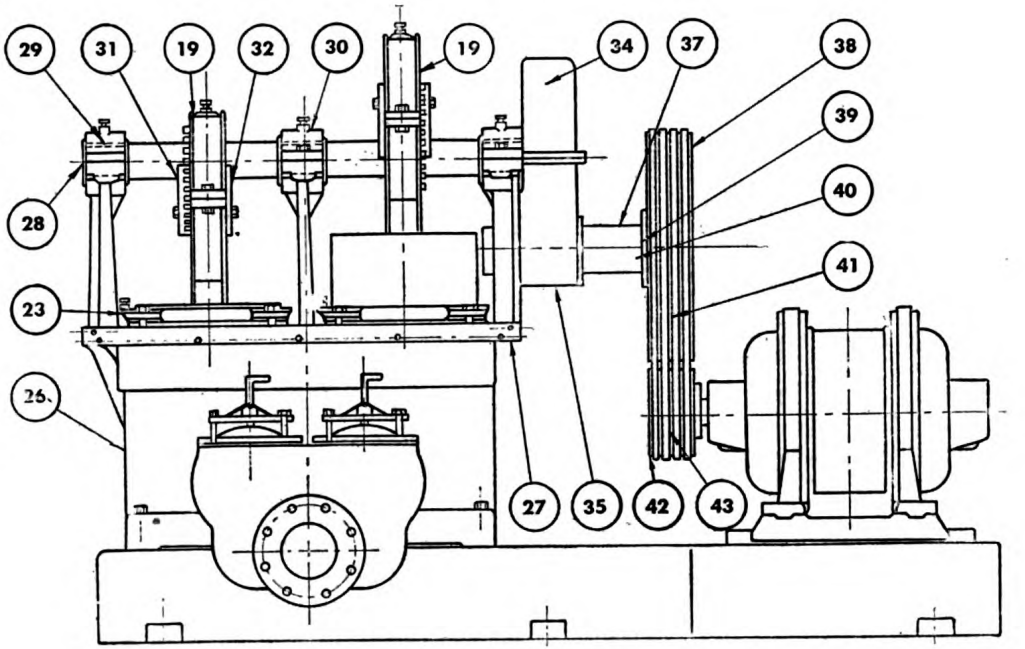
21 *b.* LUBRICATE SPEED REDUCER. Follow lubricating instructions attached to unit. For proper lubricants, see paragraph 7 and table V.

23 *c.* CLEAN AND LUBRICATE CHAIN DRIVE. Make sure chain is clean, then lubricate with OE 30.

19 *d.* CHECK OIL-CUP LEVEL. Fill oil cup with OE 30 every time pump is started. Do not let oil cup become entirely empty; refill when half empty.







1. Suction-valve-chest gasket.
2. Plunger wrist pin.
3. Connecting-rod bushing.
4. Plunger-bearing cap.
5. Plunger with bearing-flange assembly (complete).
6. Discharge-valve chest.
7. Handhole-cover gasket.
8. Handhole cover.
9. Drain pipe and cock.
10. Renewable valve seats.
11. Valve balls.
12. Valve-lid gasket.
13. Valve-chest lid.
14. Valve-chest-lid clamp.
15. Discharge-valve-chest gasket.
16. Connecting rod.
17. Driven-pinion-shaft, rear bushing.
18. Driveshaft.
19. Eccentric strap.
20. Eccentric hub.
21. Eccentric.
22. Gear-case top.
23. Gland.
24. Plunger packing.
25. Suction-valve chest.
26. Cylinder.
27. Side plate.
28. Driveshaft-bearing shims.
29. Driveshaft shell bearing.
30. Driveshaft-bearing cap.
31. Front clamp.
32. Rear clamp.
33. Alemite fittings.
34. Herringbone 100-T gear.
35. Herringbone 17-T pinion.
36. Texrope guard.
37. Driven-sheave-pinion shaft.
38. Driven sheave.
39. Driven-pinion-shaft front bushing.
40. Driven-pinion-shaft bearing.
41. Texrope drive (complete).
42. Driving sheave.
43. Texropes.

Figure 13. Barnes-Dorrco sludge pump.

W | M | Q | S | A

22

e. LUBRICATE WRIST PINS. Lubricate wrist pin at bottom of connecting rod with OE 30, filling inside of piston to top of clevis. Inspect oil for water or sludge. If piston contains layer of water or sludge under the oil, drain piston by removing drain plug; flush and refill with clean oil.

f. CHECK OIL LEVEL IN PACKING GLAND. Flood reservoir in gland with OE 30 before starting pump, and keep proper oil level during operation. When oil becomes sludged, drain through tapped opening in side of cylinder and refill with new oil.

24

g. CLEAN AND LUBRICATE PILLOW BLOCKS. Pillow blocks are usually packed with enough grease for 6 months' service under average operating conditions. Lubricate with WB 2 grease, taking care not to force too much grease into pillow blocks.

25

h. FLUSH OUT PILLOW BLOCKS. Dismantle pillow blocks and flush out bearings with clear kerosene. Never use gasoline. Pack bearings with grease before reassembling and mounting them on pumps.

36. Domestic Pumps (CSEPS, CDEPS, SEPS, and DEPS Types)

a. PERFORM GENERAL PUMP MAINTENANCE. See paragraph 32.

b. LUBRICATE ECCENTRIC. Turn down grease cup on eccentric one or more turns every 4 hours. When lubricant in grease cup runs low refill cup with WB 2.

30

c. LUBRICATE BALL BEARING. Lubricate bearings with BR grease applied with a grease gun.

31

Flush and refill.

29

d. CLEAN AND LUBRICATE ROLLER CHAIN. Lubricate roller-chain drive, types CSEPS and CDEPS, by brushing heavy oil into chain, preferably on the inside surfaces. Use CW 2, which adheres well yet penetrates to internal rubbing surfaces.

33

e. REMOVE AND CLEAN CHAIN. Use method discussed in paragraph 17.

f. CLEAN AND LUBRICATE GEAR CASE. Lubricate type SEPS and DEPS gears with NS 5150. Keep oil level with top of fill connection.

32

Drain, flush, and refill gear case.

g. LUBRICATE PACKING AND PISTON. Lubricate packing and piston with NS 6135. Keep reservoir at top of stuffing box about half full.

37. Marlow Pumps (PE and RPE Types)

a. PERFORM GENERAL PUMP MAINTENANCE. See paragraph 32.

34

b. CHECK OIL LEVEL IN TYPE PE REDUCTION-GEAR CASE. Fill reduction-gear case on PE pumps with NS 5150 to level indicated by top plug in drain pipe (No. 3, fig. 14). Maintain level at all times.

35

c. LUBRICATE GEAR MOTOR (TYPE RPE). Follow closely the factory lubricating instructions attached to gear motor. See also paragraph 14.

36

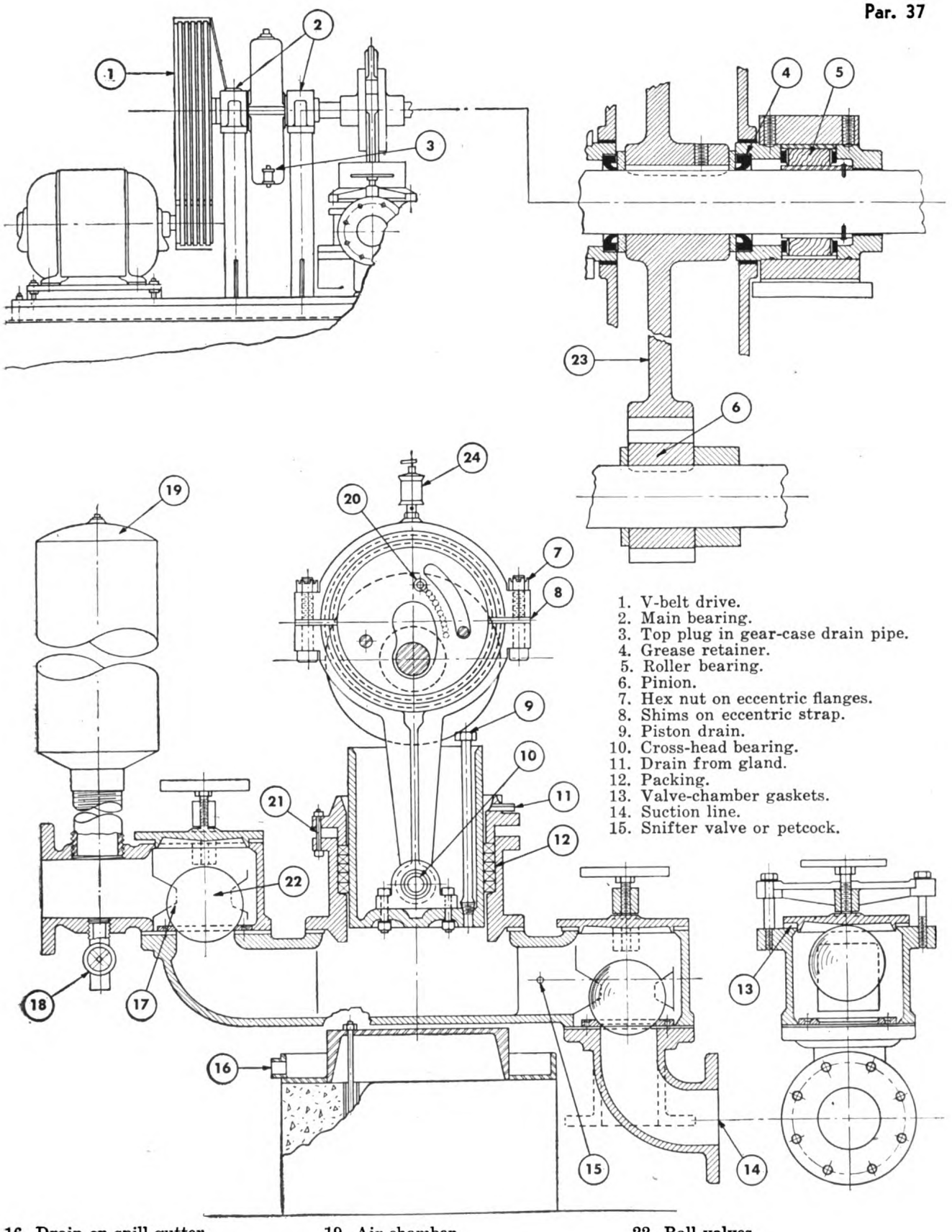
d. CLEAN AND LUBRICATE CHAIN DRIVE (TYPE RPE). Keep roller chain drive on RPE type clean and lubricate with OE 30 or CW 2.

37

e. LUBRICATE MAIN BEARINGS. All main bearings are totally enclosed roller bearings provided with grease cups. Fill grease cups with BR grease.

38

f. LUBRICATE CROSS-HEAD BEARING. Lubricate cross-head bearing at bottom of plunger (No. 10, fig. 14) with OE 30. Fill plunger to cover the pin.



1. V-belt drive.
2. Main bearing.
3. Top plug in gear-case drain pipe.
4. Grease retainer.
5. Roller bearing.
6. Pinion.
7. Hex nut on eccentric flanges.
8. Shims on eccentric strap.
9. Piston drain.
10. Cross-head bearing.
11. Drain from gland.
12. Packing.
13. Valve-chamber gaskets.
14. Suction line.
15. Snifter valve or petcock.
16. Drain on spill gutter.
17. Guides in valve chamber.
18. Sampling valve.
19. Air chamber.
20. Shear pin.
21. Packing adjustment.
22. Ball valves.
23. Gear.
24. Eccentric oil cup.

Figure 14. Marlow sludge pump.

SECTION VII

VALVES AND VALVE REPAIRS

D	W	M	Q	S	A	
						38. Gate Valves
						The most common maintenance required by gate valves (fig. 15) is oiling, tightening, or replacing the stem stuffing box packing.
					3	*a.* OIL PACKING. To eliminate excessive friction between the valve stem and the packing, lubricate packing with few drops of graphite bearing oil; use GG graphited grease on packing which always requires lubrication. Stop leakage by tightening stuffing-box nuts to force packing gland tightly against packing.
					*	*b.* REPLACE PACKING. Modern gate valves can be repacked without removing them from service. Before repacking, open valve wide. This prevents excessive leakage when the packing or the entire stuffing box is removed, by drawing stem collar stem tightly against bonnet on a non-rising stem valve, and tightly against bonnet bushing on rising stem valve.
						(1) *Clean stuffing box.* Remove all old packing from stuffing box with a packing hook or a rat-tail file with bent end. Clean valve stem of all adhering particles and polish it with fine emery cloth.
						(2) *Insert packing.* Insert new split-ring packing in stuffing box and tamp it into place with packing gland. Stagger ring splits. After stuffing box is filled, place a few drops of oil on stem, assemble gland, and tighten it down on packing.
			1			*c.* OPERATE VALVE. Operate inactive gate valves to prevent sticking.
					4	*d.* LUBRICATE GEARING. Lubricate gate valves as recommended by manufacturer. Lubricate thoroughly any gearing in large gate valves. Wash open gears with kerosene and lubricate with WB 2 grease or NS 5190.
			2			*e.* LUBRICATE RISING-STEM THREADS. Clean threads on rising-stem gate valves and lubricate with WB 2 grease.
					5	*f.* LUBRICATE BURIED VALVES. If a buried valve works hard, lubricate it by pouring oil down through a pipe which is bent at the end to permit oiling the packing follower below the valve nut.
					*	*g.* REFACE LEAKY GATE-VALVE SEATS. If gate-valve seats leak, reface them immediately, using the method discussed below. A solid-wedge disk valve is used for illustration, but the general method also applies to other types of reparable gate valves. Proceed as follows:
						(1) Remove bonnet and clean and examine disk and body thoroughly. Carefully determine extent of damage to body rings and disk. If corrosion has caused excessive pitting or eating away of metal, as in guide ribs in body, repairs may be impractical.
						(2) Check and service all parts of valve completely. Remove stem from bonnet and examine it for scoring and pitting where packing makes

Abbreviations: D, means daily; W, weekly; M, monthly; Q, quarterly; S, semiannually; A, annually.

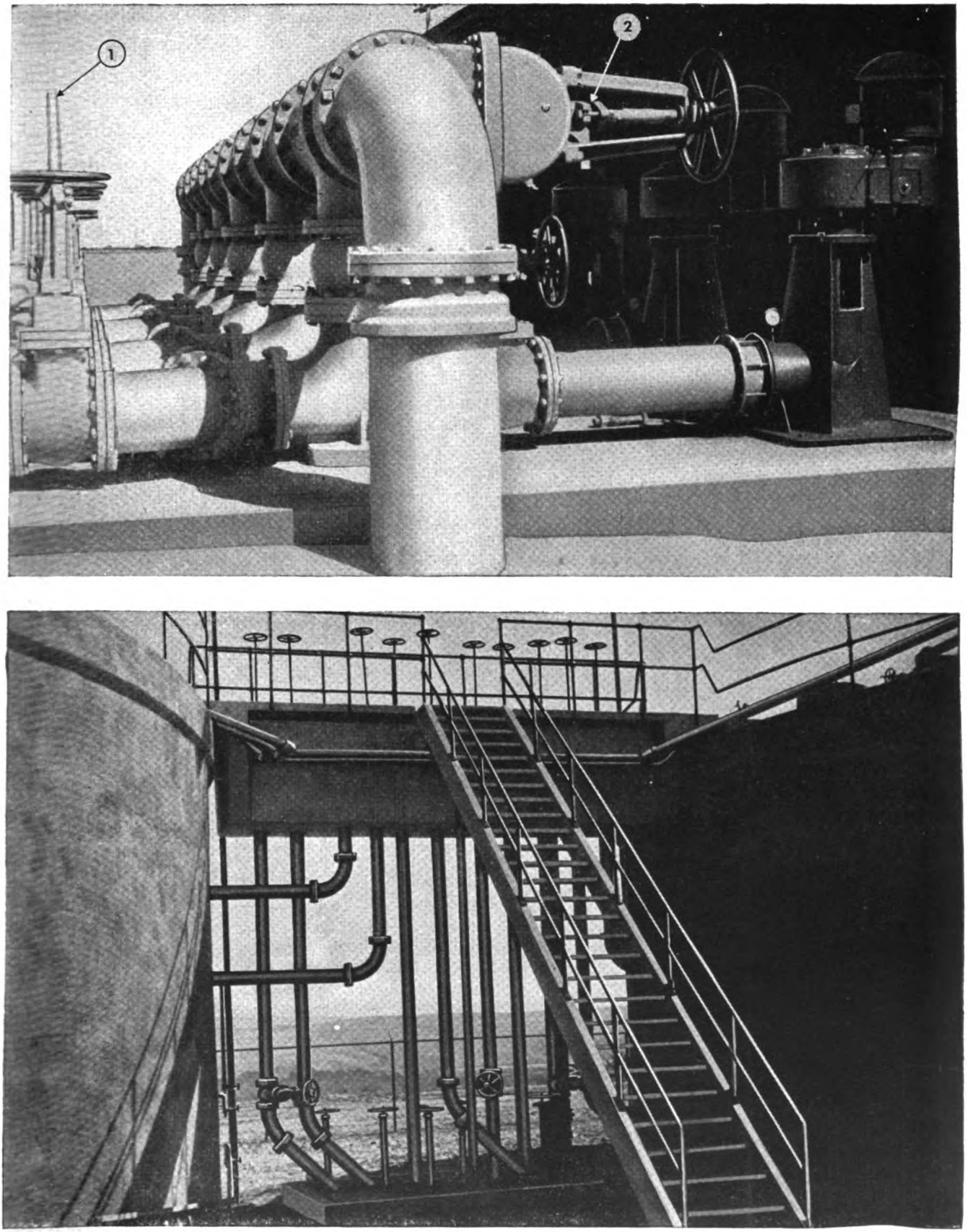


Figure 15. *In installations of this type, proper gate-valve maintenance is vital to uninterrupted operation. Keep* ***threads*** *and stem (1) lubricated with graphite and make sure* ***stuffing-box*** *packing (2) is oiled and tight.*

contact. Polish lightly with fine emery cloth to put stem in good condition. Use soft jaws if stem is put in vise.

(3) Remove all old packing and clean out stuffing box. Clean all dirt, scale, and corrosion from inside of valve bonnet and other parts.

(4) Do not salvage an old gasket. Remove it completely and replace with one of proper quality and size.

(5) After cleaning and examining all parts, determine whether valve can be repaired by removing cuts from disk and body-seat faces or by replacement of body seats. If repair can be made, set disk in vise with face leveled, wrap fine emery cloth around a flat tool and rub or lap off entire bearing surface on both sides to a smooth, even finish. Remove as little metal as possible.

(6) Repair cuts and scratches on body rings, lapping with an emery block small enough to permit convenient rubbing all around rings. Work carefully to avoid removing so much metal that disk will seat too low. When seating surfaces of disk and body rings are properly lapped in, coat faces of disk with Prussian blue and drop disk in body to check contact. When good, continuous contact is obtained, valve is tight and ready for assembly. Insert stem in bonnet, install new packing, assemble other parts, attach disk to stem, and place assembly in body. Raise disk to prevent contact with seats so bonnet can be properly seated on body before tightening the joint.

(7) Test repaired valve before putting it back in line to insure that repairs have been properly made.

(8) If leaky gate-valve seats cannot be refaced, remove and replace seat rings with a power lathe. Chuck up body with rings vertical to arbor and use a strong steel bar across ring lugs to unscrew them. They can be removed by hand with a diamond-point chisel if care is taken to avoid damaging threads. Drive new rings home tightly. Use a wrench on a steel bar across lugs when putting in rings by hand. Always coat threads with a good lubricant before putting them in. Lap in rings to fit disk perfectly.

39. Merco-Nordstrom Plug Valves (fig. 16)

6 *a.* ADJUST GLAND. The adjustable gland holds plug against its seats in body, and acts through compressible packing which functions as a thrust cushion. Keep gland tight enough at all times to hold plug in contact with its seat. If this is not done, lubricant system cannot function properly and solid particles may enter between the body and plug and cause damage.

7 *b.* LUBRICATE ALL VALVES. Apply lubricant by removing lubricant screw and inserting stick of LV plug-valve lubricant for usual temperature conditions. Check valve fitting within shank to prevent line pressure from blowing out when lubricant screw is removed. Inject lubricant into valve by turning screw down as needed to keep valve in proper operating condition. If lubrication has been neglected several sticks of lubricant may be needed before lubricant system is refilled to operating condition. Be sure to lubricate valves which are not used often, to insure that they are always in operating condition. Leave lubricant chamber nearly full so extra supply is available by turning down screw. Use lubricant regularly to increase valve efficiency and service, promote easy operation, reduce wear and corrosion, and seal valve against internal leakage.

D	W	M	Q	S	A
			8		

c. LUBRICATE VALVES ON ACF PLUG-VALVE TYPE. To protect them against rust, all stock valves are filled with an assembly lubricant which is extremely soft, white, insoluble in water, and soluble in gasoline. Before placing valve in the line, lubricate it with stick of LV plug-valve lubricant which displaces assembly lubricant. This lubricant can also be used in a grease gun with gasoline as a solvent.

40. Check Valves

					9

a. INSPECT DISK FACING. Open valves to observe condition of facing on swing check valves equipped with leather or rubber seats on disk. If metal seat ring is scarred, dress it with a fine file and lap with fine emery paper wrapped around a flat tool.

					10

b. CHECK PIN WEAR. Check pin wear on balanced-disk check valve, since disk must be accurately positioned in seat to prevent leakage.

41. Globe Valves

Metal disks are suitable for throttling service, plug-type disks being preferable for severe throttling. Composition disks are not suitable and should be replaced as soon as leakage is detected to avoid cutting valve seats.

					12

a. LUBRICATE PACKING. Lubricate packing and replace as explained in paragraph 38.

			11		

b. OPERATE VALVES AND CHECK FOR LEAKAGE. Operate globe valves to prevent sticking. Check valve for leakage and replace disks if necessary.

c. REGRIND OR RENEW DISK AND SEAT. To prevent serious damage, repair disk and seat in globe valves when leakage occurs. Repairs on globe and angle valves can frequently be made without removing them from the line. The discussion below illustrates the general procedure, using a plug-type disk valve as an example; however, the method applies to other globe and angle valves, except those with composition disk.

(1) Set valve firmly in vise, straight up. Use soft jaws to prevent damage to body. Use a monkey wrench on bonnet or union ring. Do not use a pipe wrench as it will damage these parts. While parts are disassembled, inspect and clean them thoroughly. Renew packing in stuffing box, following method given for gate valves.

(2) Remove stem from bonnet. Place disk in vise and unscrew disk-stem ring.

(3) Lift out stem and insert slug or coin inside disk to take up play between disk and stem. Replace them and tighten disk-stem ring. In some valves a pin is inserted in hole to lock disk on stem.

(4) Apply a *small amount* of emery-base grinding compound to both disk and seat. Excessive amount of compound removes too much metal.

(5) Place bonnet and body together, giving bonnet or bonnet ring two or three turns by hand to provide a guide for stem. Keeping a firm hold, oscillate handwheel steadily until all pitting is removed and a continuous, smooth bearing on the seating surfaces is obtained. Do not grind more than necessary.

(6) When grinding is completed, wipe disk, seat, and body clean of all compound and dirt. Before reassembling valve, remove slug from disk to give it free swivel action on stem.

(7) When seat rings must be removed, use the specially designed tool to prevent damage to valve body,

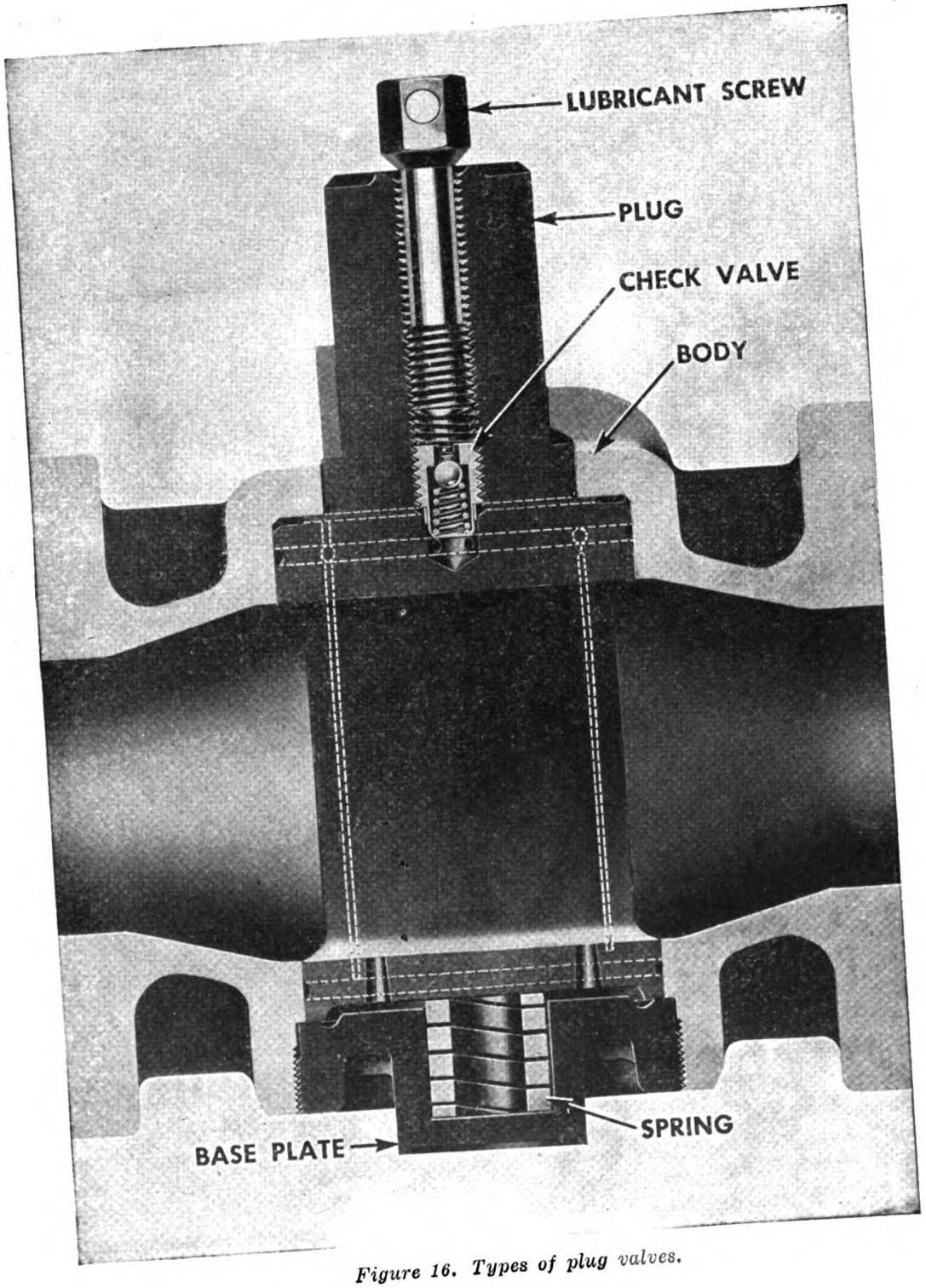


Figure 16. Types of plug valves.

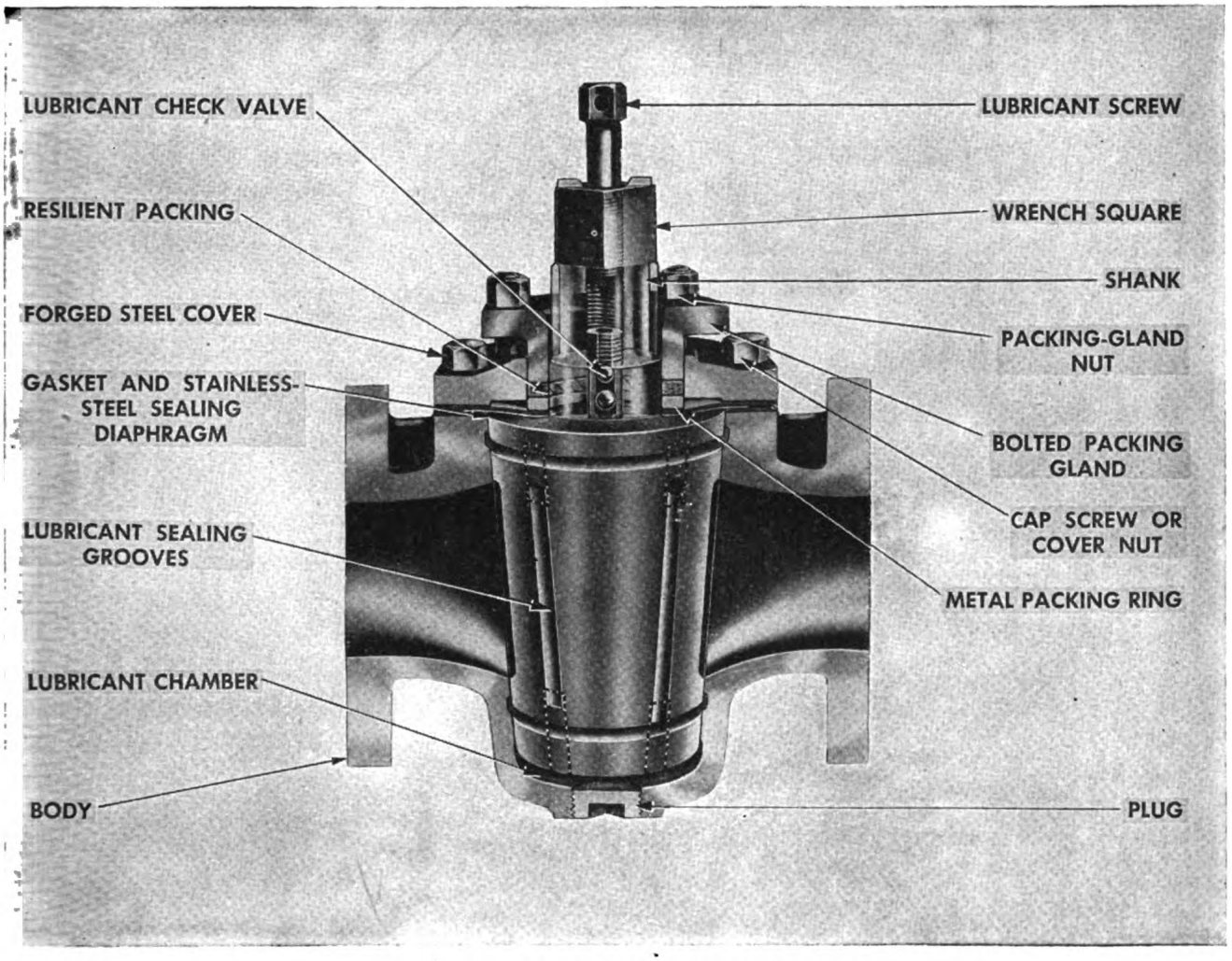


Figure 16. Types of plug valves—Continued.

D	W	M	Q	S	A
		13			
					14
					15

42. Sluice Gates

There are two general types of sluice gates: those which seat with the pressure (fig. 17) and those which seat against the pressure. Both are maintained similarly.

a. TEST FOR PROPER OPERATION. Operate inactive sluice gates. Oil or grease stem screws with WB.

b. CLEAN AND PAINT. Drain basin. Clean sluice gate with wire brush and paint with proper corrosion-resistant paint.

c. ADJUST FOR PROPER CLEARANCE. For valves seating against pressure, check and adjust ajustable top, bottom, and side wedges until in closed position each wedge applies nearly uniform pressure against gate.

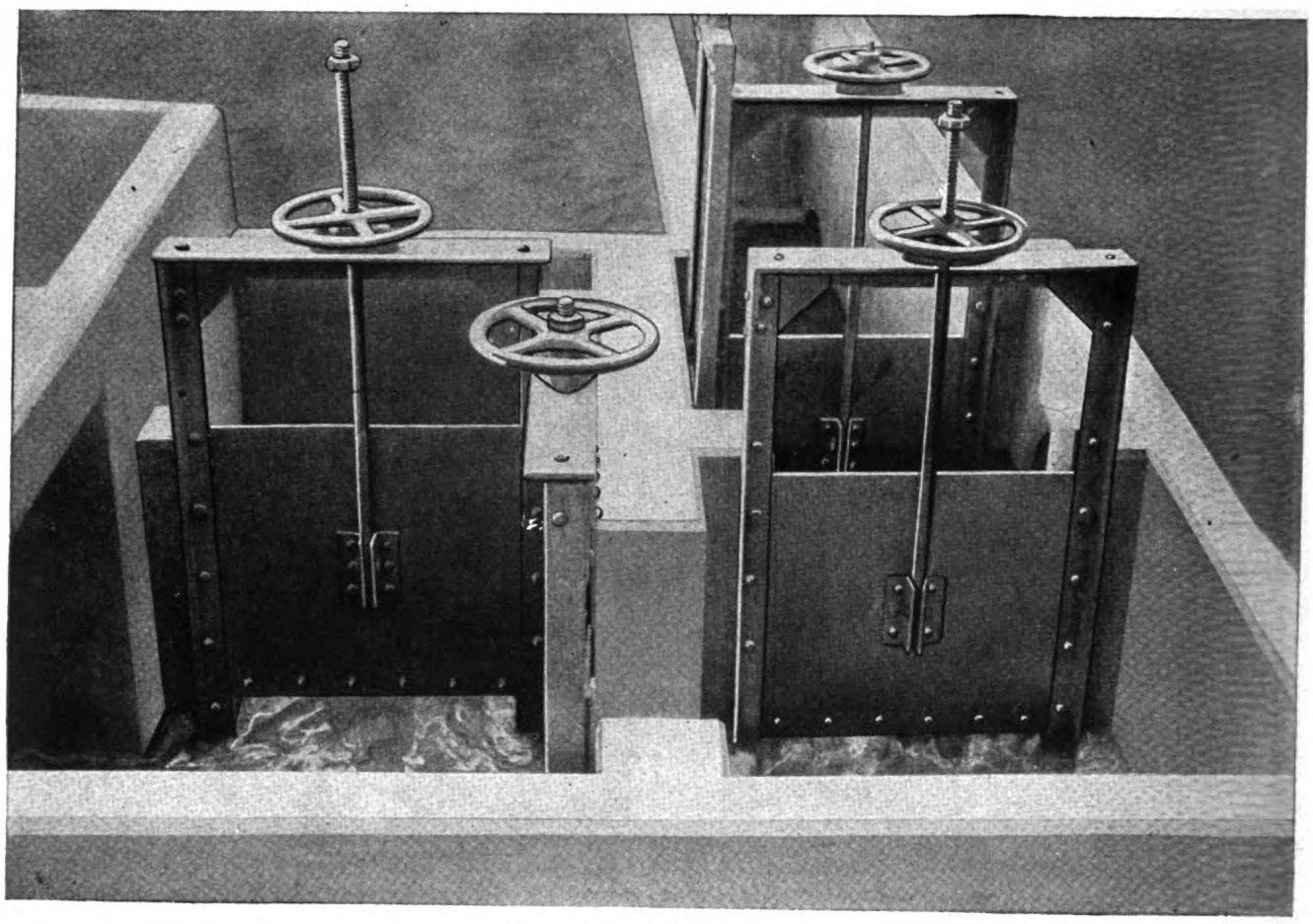


Figure 17. Sluice gates.

SECTION VIII

MECHANICALLY CLEANED BAR SCREENS AND GRINDERS

D	W	M	Q	S	A	
						43. Chain-Belt Units (MI and ME Types)
	1					*a.* LUBRICATE GEARHEAD. Drain and flush gear case and refill with proper oil selected according to the following:
						(1) For normal ambient temperature ranging from 50°F. to 85°F., use NS 5150 oil.
						(2) For high ambient temperature ranging from 85°F. to 115°F., use NS 5190.
						(3) For low ambient temperature ranging from 10°F. to 50°F., use NS 3080.
	2					*b.* LUBRICATE SHAFT BEARINGS. Grease shaft bearings with CG 0 or CG 1 grease. Underwater bearings do not require lubrication after installation.
	3					*c.* LUBRICATE DRIVE CHAINS. Grease drive chains with CG 0 or CG 1 grease.
				5		*d.* INSPECT AND ADJUST DRIVE-CHAIN ASSEMBLY. (1) *Drive chain.* Inspect drive chain and check tension. If chain is loose remove enough links to make it fairly taut.
						(2) *Sprockets.* Check sprocket alignment and adjust if necessary. Inspect sprockets for wear and replace if teeth are hooked or badly worn. Use of sprockets which are in poor condition causes excessive chain wear. (See par. 17.)
						(3) *Shear pins.* For shear-pin servicing, see paragraph 20.
		4				*e.* CHECK CONTROL MECHANISM. Oil moving parts of float control.
†						*f.* CHECK ELECTRIC MOTOR. See paragraph 14.
					6	*g.* PAINT ENTIRE MECHANISM. Use a suitable metal paint.
						44. Dorr (Type S)
				7		*a.* CHECK CONDITION. Check to see that all original alignments are maintained, that all bolts are tight, and that bearings and other parts are not excessively worn.
				8		*b.* LUBRICATE SCREEN ASSEMBLY. (1) Drain gear housing of screen, flush, and refill with NS 3065 in summer and NS 2075 in winter.
						(2) Lubricate screw sheave of S-screen with CG 1 grease.
					*	(3) Lubricate the speed reducer of S-screen according to manufacturer's instructions. For proper lubricants, see paragraph 7 and table V.
	4					*c.* LUBRICATE SHAFT BEARINGS. See paragraph 43*b*.
		4				*d.* CHECK CONTROL MECHANISM. See paragraph 43*e*.
†						*e.* CHECK ELECTRIC MOTOR. See paragraph 14.
					6	*f.* PAINT ENTIRE MECHANISM. See paragraph 43*g*.

Abbreviations: D, means daily; W, weekly; M, monthly; Q, quarterly; S, semiannually; A, annually.

W | M | Q | S | A

45. Link-Belt Units (Bar-Screen Type)

9 *a.* LUBRICATE HERRINGBONE OR HELICAL SPEED REDUCERS. Fill reducer reservoir by pouring oil into standpipe to level recommended on reducer name plate. Use NS 3065 for all temperatures below 100°F. To check oil level, remove indicator and wipe oil from stem; replace indicator, making sure cap is seated, then remove indicator again and check position of oil on stem. Replace indicator, pressing down on cap and turning it clockwise to lock it in place.

Caution: Reducer must be at rest when oil is being added or oil level checked. Do not add too much oil because agitation of excess oil generates considerable heat.

11 Change lubricant.

10 *b.* SERVICE SHEAR PINS. See paragraph 20.

2 *c.* LUBRICATE SHAFT BEARINGS. See paragraph 43*b*.

3 *d.* LUBRICATE DRIVE CHAINS. See paragraph 43*c*.

5 *e.* INSPECT AND ADJUST DRIVE-CHAIN ASSEMBLY. See paragraph 43*d*.

4 *f.* CHECK CONTROL MECHANISM. See paragraph 43*e*.

g. CHECK MOTOR. See paragraph 14.

6 *h.* PAINT ENTIRE MECHANISM. See paragraph 43*g*.

46. Link-Belt Units (Tritor Type)

12 *a.* CHECK OIL LEVEL IN REDUCER. Keep reducer filled with oil to marking line.

16 *b.* DRAIN AND REFILL REDUCER HOUSING. Use NS 3065 oil. Drain more frequently if inspections show that oil loses its body in less than 6 months.

13 *c.* GREASE BEARINGS. For proper lubricants, see paragraph 7 and table V.

17 *d.* CLEAN AND LUBRICATE ROLLER CHAIN. For procedure, see paragraph 17. For lubricants, see paragraph 7 and table V.

14 *e.* OIL LIMIT-SWITCH ROLLER ARM. Use OE 10.

15 *f.* SERVICE SHEAR PINS. See paragraph 20.

2 *g.* LUBRICATE SHAFT BEARINGS. See paragraph 43*b*.

3 *h.* LUBRICATE DRIVE CHAINS. See paragraph 43*c*.

5 *i.* INSPECT AND ADJUST DRIVE-CHAIN ASSEMBLY. See paragraph 43*d*.

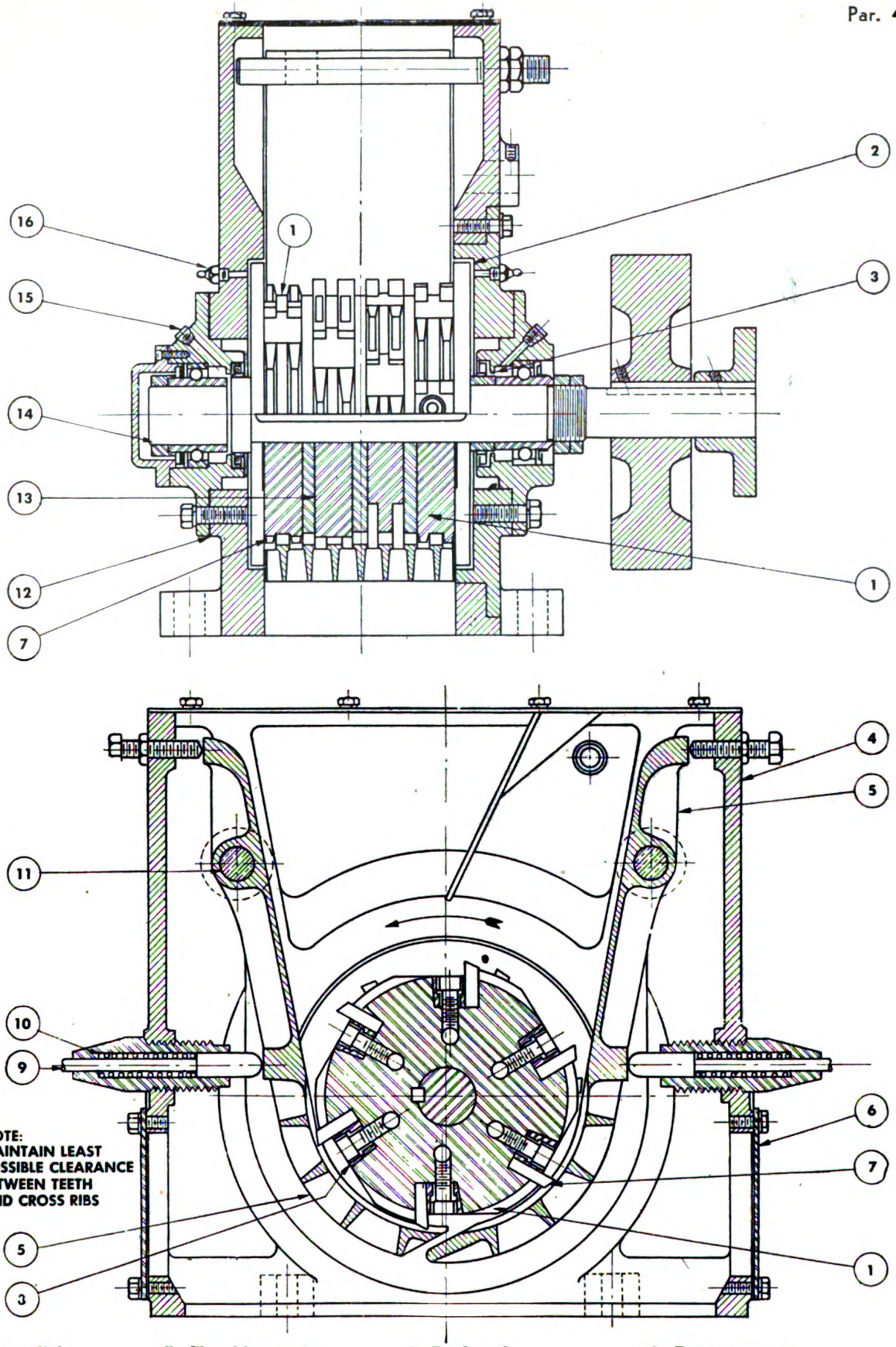
4 *j.* CHECK CONTROL MECHANISM. See paragraph 43*e*.

k. CHECK MOTOR. See paragraph 14.

6 *l.* PAINT ENTIRE MECHANISM. See paragraph 43*g*.

47. Chain-Belt Units (Triturator Type)

19 *a.* LUBRICATE TRITURATOR BEARINGS. Maintain grease in bearing seals by lubricating bearings with BR grease, added through bearing lubrication fitting. (See No. 15, fig. 18.) *Do not overlubricate;* at high operating speeds, overlubrication causes overheating.



1. Cutter disk.
2. Sealing rings.
3. Spacer.
4. Shredder housing.
5. Shredder grate.
6. Inspection hole.
7. Cutting blade.
8. Cutting-blade holders.
9. Push rod.
10. Spring.
11. Grate pivot shaft.
12. Bearing gasket.
13. Rotor spacers.
14. Rotor shaft.
15. Bearing lubrication fitting.
16. Sealing-ring lubrication fitting.

Figure 18. Triturator.

D | W | M | Q | S | A

18

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b. LUBRICATE SEALING RINGS. Force grease behind sealing rings through sealing-ring lubrication fitting (No. 16, fig. 18), preferably while machine is running. Keep this small opening packed with grease to prevent entrance of minute particles and to keep rotor free so it can be turned easily by hand.

Note. Use only Rex Hydro-Seal lubricant, sold exclusively by Chain Belt Company to lubricate sealing rings. Rex Hydro-Seal is *not* recommended for bearings and bearing grease is not recommended for sealing rings.

c. CHECK GRATE-TO-ROTOR CLEARANCE. Maintain a grate setting as close to rotor as possible, with no clearance between crossbar cutting edges of grates and teeth of rotor.

d. CHECK GRATES FOR WEAR OR DAMAGE. Because a badly rounded cross rib impairs cutting efficiency as much as dull teeth, replace grates which are so worn that proper clearance cannot be maintained.

e. INSPECT CUTTING EDGE OF TEETH. Keep teeth reasonably sharp, removing them for sharpening as soon as they have worn down approximately $\frac{1}{32}$ inch. Since manufacturer has precision tools required for grinding, returning teeth to manufacturer for servicing is recommended. Keep an extra set of teeth on hand.

48. Comminutors (fig. 19)

a. LUBRICATE LOWER SHAFT BEARING. Proper lubrication protects lower shaft bearing and prevents sewage from penetrating to bearing through lower oil seal. (See No. 17, fig. 19.) Lubricate with CG 0 grease in winter and CG 1 in summer, added through the grease fitting. (See No. 9 fig. 19.) After lubricating, replace waterproof cap on grease fitting. Amount of grease depends on type of comminutor as follows:

(1) 10A comminutors: 12 strokes of grease gun, $\frac{1}{6}$ ounces.

(2) 15M and 25M comminutors: 18 strokes of grease gun, $\frac{1}{4}$ ounces.

(3) 25A comminutor: 24 strokes of grease gun, $\frac{1}{2}$ ounces.

(4) 36A comminutor: 30 strokes of grease gun, $\frac{3}{5}$ ounces.

b. CHECK OIL LEVEL IN GEAR REDUCER. Add oil as required to fill to oil-level mark. For atmospheric temperatures from –10°F. to 32°F., use NS 2190; from 32°F. to 70°F., use NS 3050; from 70°F. to 130°F., use NS 3065.

Note. Shaft-extension universal joints and spline require no lubrication.

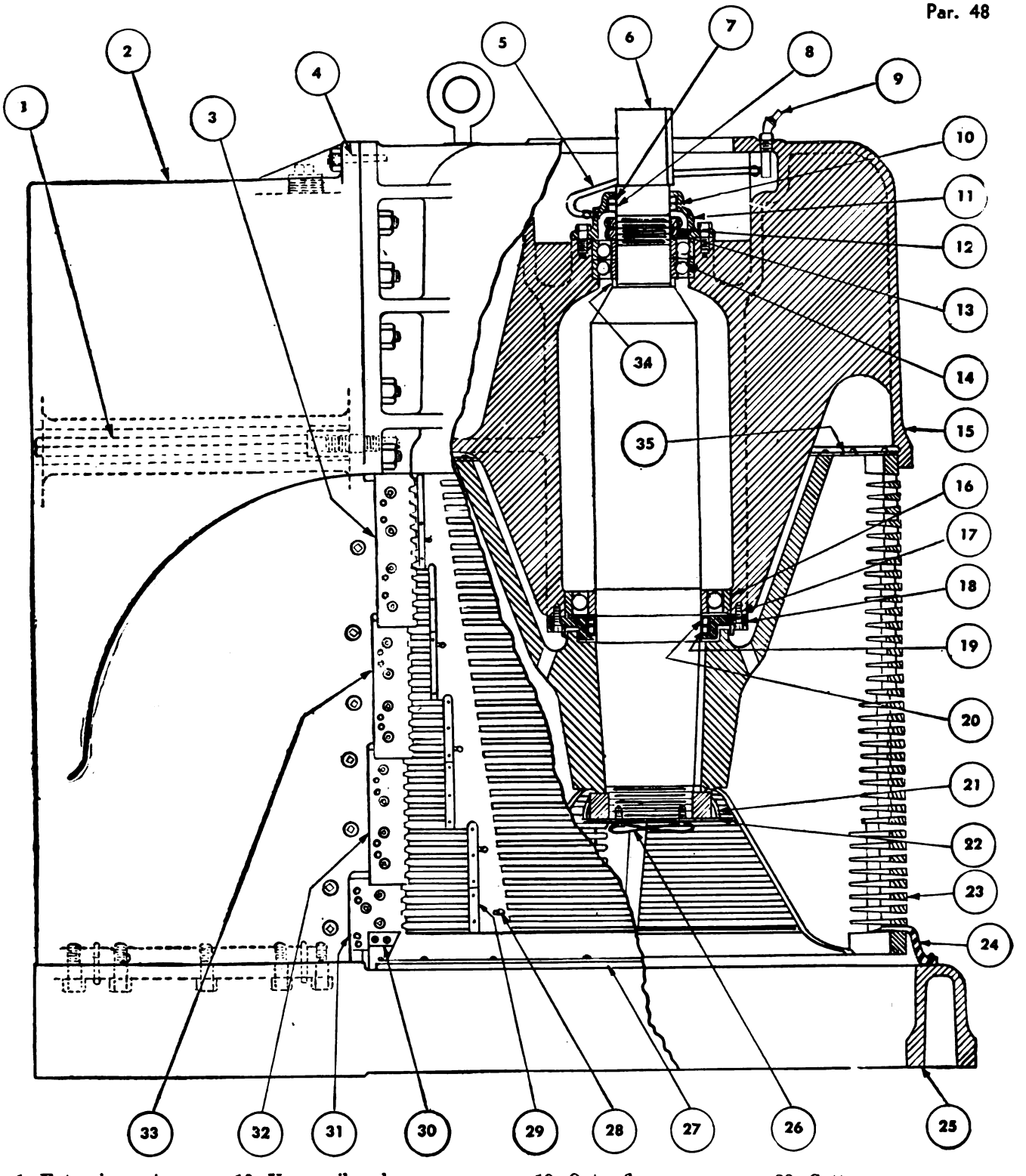
c. CHECK OPERATING LIMITS. Control storm flows to prevent sewage from rising above top of bearing housing. See that normal dry-weather fluctuations in sewage level at comminutor do not rise higher than the following:

(1) For 10A, 15M, and 25M comminutors, 10 inches above top of drum. (See No. 23, fig. 19.)

(2) For 25A and 36A comminutors, 15 inches above top of drum.

d. LUBRICATE SUBMERGED BEARINGS. If storm flows or other fluctuations of flow cannot be controlled to limits given above, install automatic lubricator to keep comminutor continuously lubricated and to protect submerged bearings.

e. INSPECT AND SERVICE COMMINUTOR ASSEMBLY. Clean comminutor basin as necessary and inspect working parts of comminutor. Also inspect com-



1. Extension nut.
2. Column.
3. Top comb.
4. Taper pin.
5. Grease line.
6. Shaft.
7. Outer flange.
8. Inner flange.
9. Grease fitting.
10. Upper oil seal.
11. Upper bearing cap.
12. Ball-bearing locknut.
13. Ball-bearing lock washer.
14. Duplex bearing.
15. Bearing housing.
16. Max-type ball bearing.
17. Lower oil seal.
18. Lower bearing cap.
19. Outer flange.
20. Inner flange.
21. Lower shaft nut.
22. Lock.
23. Drum.
24. Base seal.
25. Base.
26. Keeper wire.
27. Base seal retainer.
28. Cutter.
29. Shear bar.
30. Comb seal retainer.
31. Bottom comb.
32. Lower center comb.
33. Upper center comb.
34. Spacer.
35. Drum cover.

① Cross section, *Comminutor.*

Figure 19.

D	W	M	Q	S	A
24					
25					
		30			
	29				
†					

minutor immediately after any abnormal flow due to storms and sewer flushing. For this inspection drain comminutor basin and the approach channel if possible and wash comminutor and basin clean with a hose.

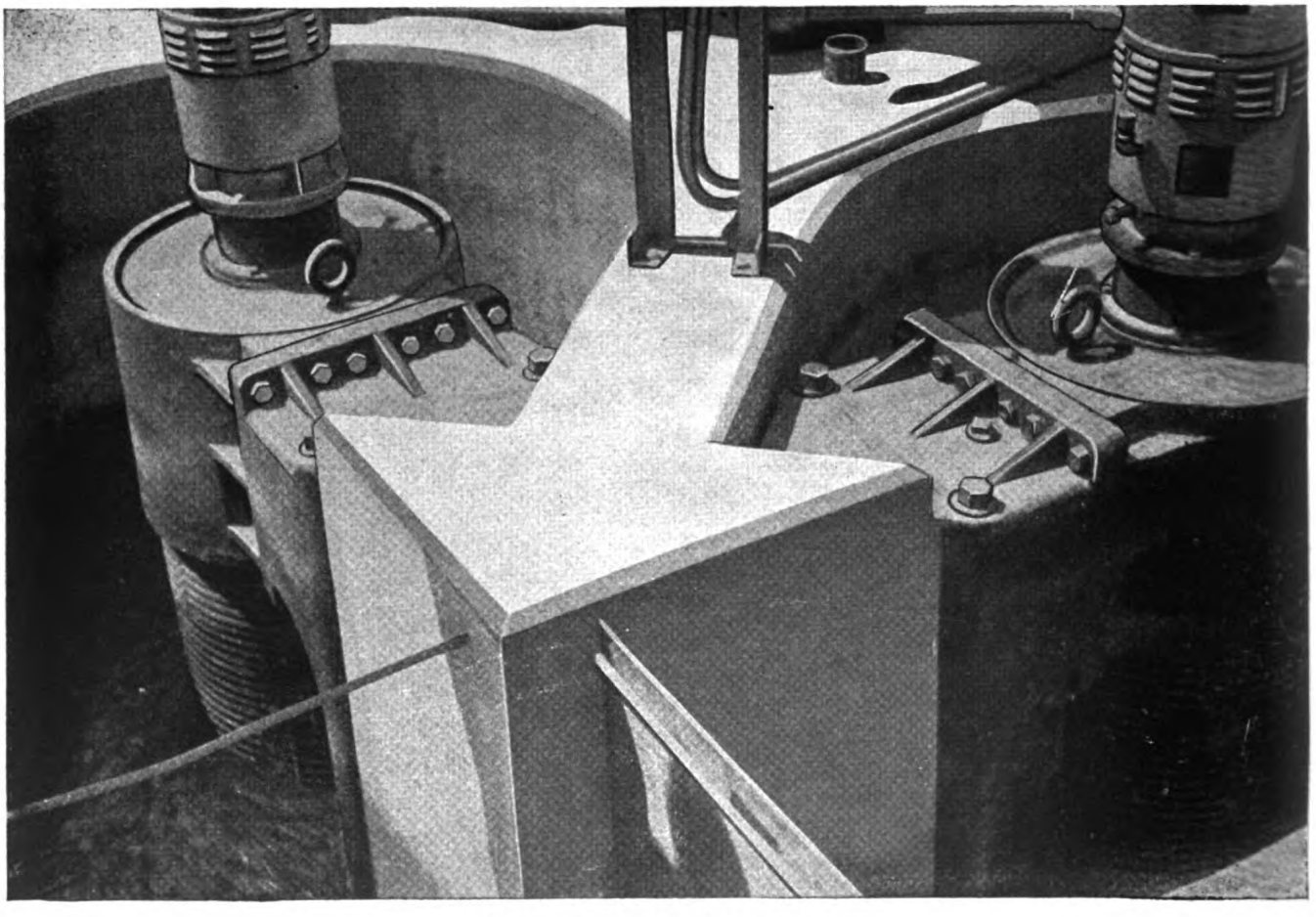
f. REMOVE GRIT. Flush thoroughly with a hose to remove grit from bottom of comminutor chamber.

g. CLEAN COMB. To clean comb, run a stock of wood up and down cutting edges as comminutor rotates.

h. INSPECT CUTTING EDGES. Examine each cutter and replace if dull. (See fig. 20.) Inspect shear bars and replace those with a groove deeper than 0.020 inch worn across the face. Replace any badly chipped or damaged comb section. Try a 0.012-inch thickness gauge in the C clearance at bottom end of comb section. (See fig. 20④.) If comb section is so worn that gauge enters, replace comb.

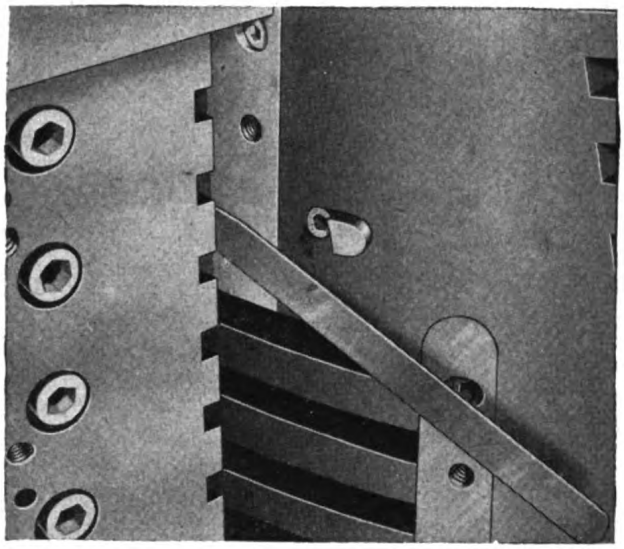
i. INSPECT BASE SEAL. Replace base seal (No. 24, fig. 19) which is worn or damaged enough to allow rags to pass or wedge between base seal and drum. (See No. 23, fig. 19.) With basin drained, remove bottle caps, stones, and the like and flush drum slats with hose stream to prevent grease accumulation.

j. CHECK MOTOR CONDITION. See paragraph 14.



② *Comminutor installation.*

Figure 19.—Continued.



1. Tooth which is in this condition must be sharpened immediately. Otherwise, continued use will wear off the top flat and the tooth will have to be replaced.
2. Worn tooth which has been sharpened.
3. This tooth was not sharpened in time and is entirely worn out. It must be replaced.
4. Measuring C clearance to check comb wear.

Figure 20. Comminutor teeth and comb.

SECTION IX

GRIT-CHAMBER EQUIPMENT

W	M	Q	S	A	
					49. Chain-Belt Equipment (MA, ME, MI and MIN Types) and Link-Belt Equipment (fig. 21①)
2					*a.* LUBRICATE AND SERVICE REDUCERS. Check oil level and examine oil for water condensation. If water condensation is present, drain completely, flush out, and refill. If reducer runs hot, check oil level; too much or too little oil causes overheating. If reducers are idle long, fill completely with oil to prevent seals from drying out. See paragraph 43*a* for lubrication of MI and ME types. See paragraph 7 and table V for lubrication of other types.
3					*b.* LUBRICATE SHAFT BEARINGS. Grease shaft bearings with CG 1 or CG 0 grease. Grease underwater babbitted bearings only if they are equipped with grease pipes. Never grease eel-slip bushed bearings; they are water lubricated.
4					*c.* GREASE DRIVE CHAINS. Grease drive chains used on grit collectors with CG 0 or CG 1 grease.
	5				*d.* SERVICE CHAINS AND SPROCKETS. See paragraph 17.
			7		*e.* INSPECT LOWER BEARING OF GRIT WASHER (TYPE MA). Drain washer hopper for complete inspection of lower bearing of grit washer. If lower bearing of screw conveyor is worn until screw touches liner of trough, replace bearing.
				10	*f.* CHECK WATER LINE. Inspect water-line back-siphonage preventer to tapped hole of bearing housing. Keep countercurrent between two wearing surfaces, preventing entrance of minute grit particles. Water line can be an extension of sluice-water source without intermediate valve so water pressure is always provided at bearing when water is turned on for sluice trough. If no water is available, provide a fitting at tapped hole on bearing housing and lubricate bearing with Rex Hydro-Seal lubricant, sold exclusively by Chain Belt Company.
				*	*g.* INSPECT SPACE BETWEEN SCREW AND TROUGH. Large stones, bottle caps, or similar debris working into clearance space between screw and trough may cause a loud thumping noise which is not detrimental unless allowed to continue for some time. If machine fails to clear itself, allow an excess of sand to accumulate in washer before running; the excess sand then carries out the troublesome solids.
			8		*h.* CHECK GRIT-BUCKET WEARING SHOES. If wearing shoes have worn down about 5/8 inch, replace with new shoes or reverse buckets so opposite wearing shoes wear on tank bottom. To reverse bucket, remove pin located between chain attachment and wearing shoe, turn bucket through 180°, and replace pin.

Abbreviations: D, means daily; W, weekly; M, monthly; Q, quarterly; S, semiannually; A, annually.

D	W	M	Q	S	A
		6			
†					
				9	
					11
				18	
			15		
		14			
12					
			16		
			17		
13					
					19
†					

i. SERVICE SHEAR PINS. See paragraph 20.

j. SERVICE ELECTRIC MOTORS. See paragraph 14.

k. CHECK ALIGNMENT. See paragraph 17.

l. DRAIN IN FREEZING WEATHER. If washer is to stand idle long in freezing weather, drain chamber.

50. Dorrco Detritor Mechanism (fig. 21②)

a. CHECK FOR TIGHTNESS. Keep all bolts and nuts tight and maintain original alignment and adjustments.

b. EXAMINE WEARING PARTS. Check for excessive wear. Find and correct causes.

c. CHECK HORIZONTAL AND VERTICAL ROLLERS. Inspect for proper lubrication and free movement in center unit mechanism. Lubricate with BR grease.

d. CLEAN CLEANING MECHANISMS ON TYPES C AND D UNITS. Clean face of cam roller or cam but *do not grease them.* Lubricate cam roller pin with BR grease.

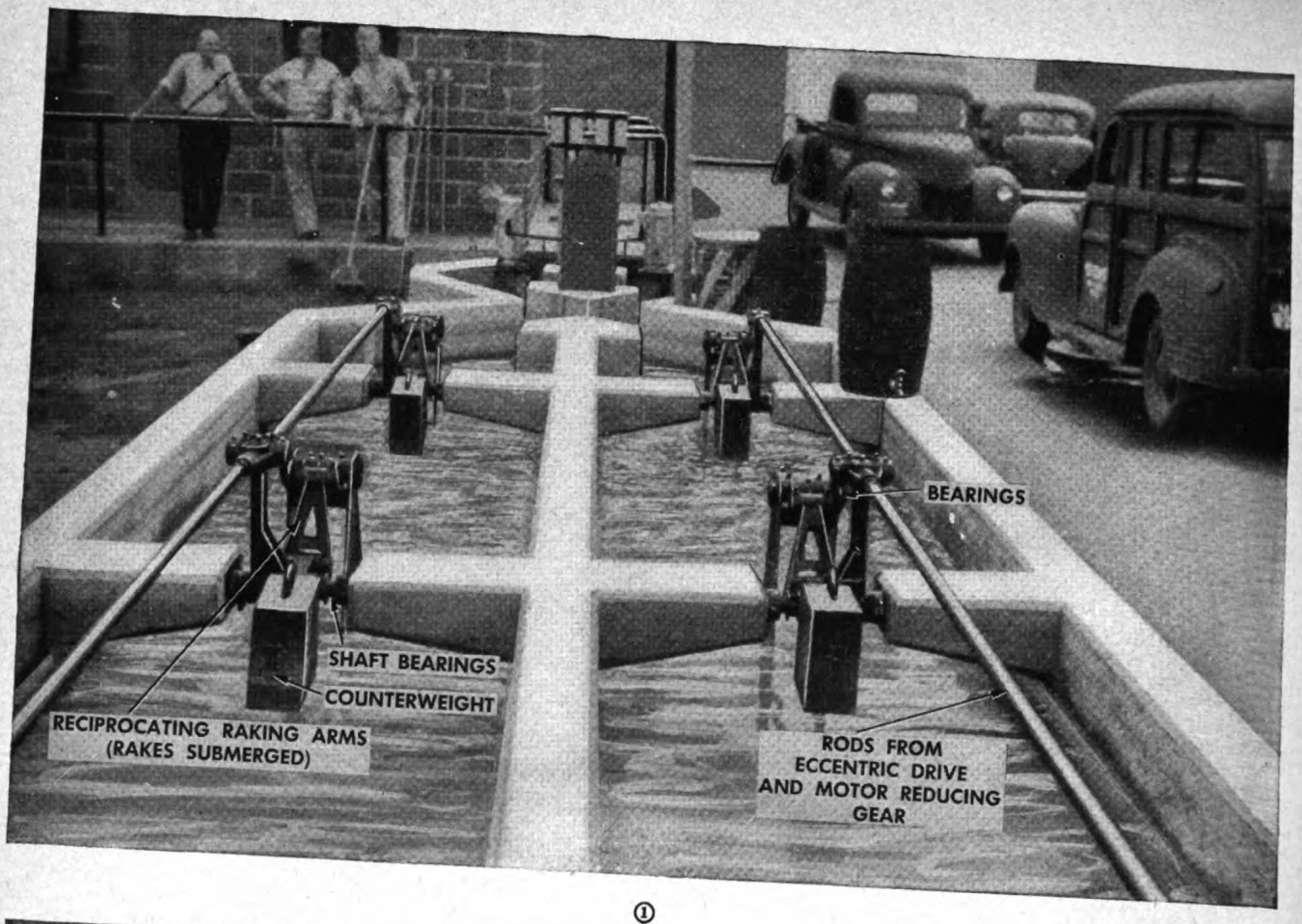
e. LUBRICATE WORM-GEAR DRIVE. Use NS 6135 oil in summer and NS 3080 in winter. When necessary to refill, wash out housing with kerosene.

f. LUBRICATE SPEED REDUCER. Use NS 6135 oil in summer and NS 3080 in winter. Keep oil level between the two overflow cocks.

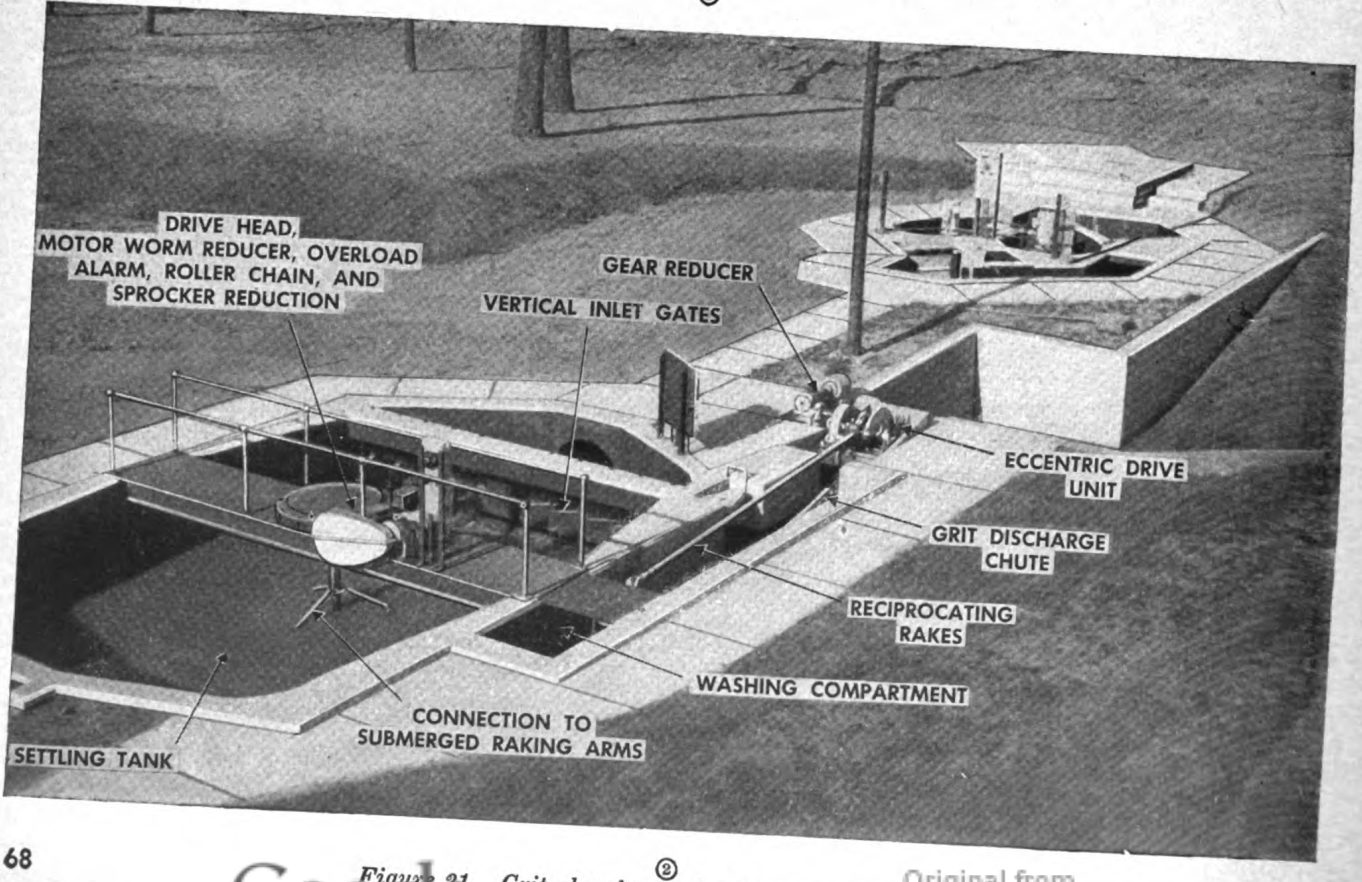
g. GREASE BEARINGS. Lubricate all other bearings with CG 1 grease.

h. PAINT. Coat entire mechanism with suitable metal paint. In addition, touch up rusted spots as they occur.

i. CHECK MOTOR CONDITION. See paragraph 14.



①



②

Figure 21. Grit chamber and detritor installation.

SECTION X

SEDIMENTATION-TANK EQUIPMENT (REVOLVING TYPE)

D	W	M	Q	S	A

51. Dorr (Type A)

Recommended frequencies for lubricating Dorr type-A clarifiers (fig. 22) are based on continuous operation. If the machine is operated intermittently, decrease frequency to suit actual operating time. If machine is to be idle for a long time, take special precautions to prevent damage and, if practicable, operate mechanism for a few minutes each week to keep working parts, balls, races, and gears thoroughly coated with lubricant. If machine is outdoors or in a cold climate change grade of lubricant with the seasons, particularly the heavy worm-gear oils which do not flow readily at below-freezing temperatures.

	4				

a. INSPECT AND LUBRICATE REDUCERS AND OIL BATHS. Check oil level in speed reducers and oil baths, and see that oil is clean and of good body. Drain a small amount of oil from bottom of gear casing and oil baths to eliminate any accumulated water. If oil is gritty or lacks body and oiliness, change it promptly.

1					

(1) *Lubricate drive head.* When machine is operated continuously, lubricate counter-shaft bearings with a small amount of CG 1 grease forced through each of the three button-head Alemite fittings. *Do not overlubricate.* Excess grease enters worm-gear housing and mixes with oil, producing a heavy oil which will not flow properly around ball bearings and worm gears. Excess grease may also enter overload-alarm box, which should *not* be lubricated. Too much grease in fitting next to sprocket may force shaft seal out of place.

	5				

(2) *Lubricate worm-gear and turntable bearing.* (*a*) *Check oil level.* If low, remove worm-gear cover and fill housing slowly until oil flows out of overflow elbow. Use NS 3080 oil in winter and NS 6135 in summer. The first few revolutions of machine lubricate ball race and balls thoroughly. Make sure overflow elbow points downward.

				11	

(*b*) *Drain and refill.*

		7			

(3) *Drain moisture from housing.* Open drain on gear housing and remove accumulated water.

		8			

b. LUBRICATE ROLLER CHAIN. (1) If chain guard is totally inclosed, chain is lubricated by dipping into an oil bath. Open drain plug and draw off accumulated water. Put oil into chain guard through inspection opening in its side. Use NS 3065 in summer and NS 2075 in winter.

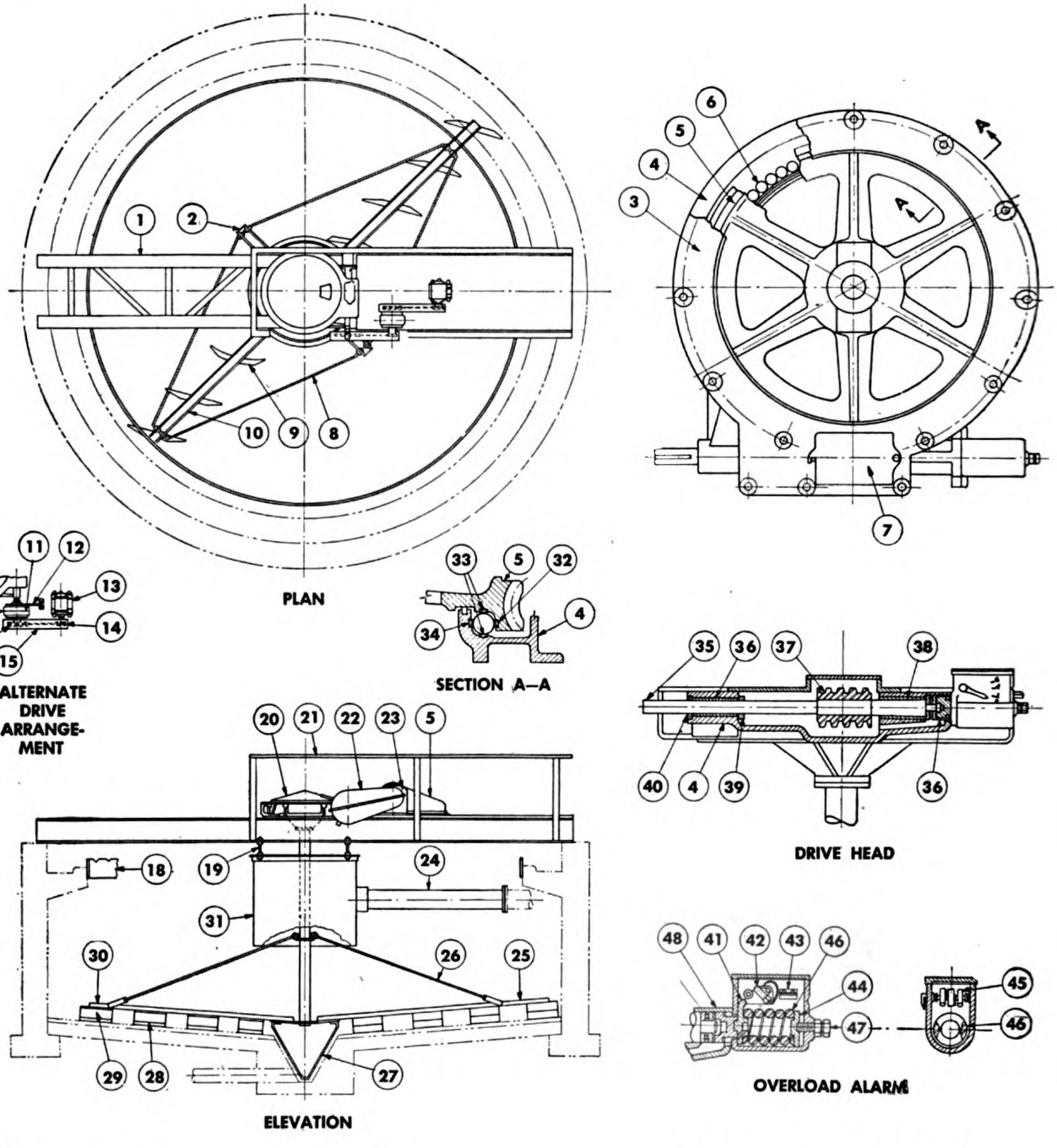
	6				

(2) If chain guard is semi-inclosed, chain is not lubricated by oil bath because bottom of guard is open. Apply lubricant by squirting or brushing it onto chain. Use roller-chain lubricant throughout the year or NS 6135 in summer and NS 3080 in winter.

				12	

(3) Flush and change oil.

Abbreviations: D, means daily; W, weekly; M, monthly; Q, quarterly; S, semiannually; A, annually.



1. Mechanism support.
2. Stub arm.
3. Gear-housing cover.
4. Gear housing.
5. Worm gear.
6. Steel-roller balls.
7. Worm cover.
8. Drive rod or angle.
9. Blades.
10. Long rake arm.
11. Bushing.
12. Torque arm and bracket.
13. Motor.
14. Drive pulley.
15. V-belts.
16. Driven pulley.
17. Reducer.
18. Weir plate.
19. Influent-well support.
20. Worm-gear cover.
21. Handrail.
22. Chain guard.
23. Reducer support frame.
24. Influent pipe.
25. Long rake arm.
26. Tie road.
27. Center scraper.
28. Squeegees.
29. Blades.
30. Short rake arm.
31. Influent well.
32. Outer strip liner.
33. Upper and lower strip liner.
34. Inner strip liner.
35. Countershaft.
36. Thrust ball bearing.
37. Worm.
38. Bushing.
39. Set collar.
40. Oil seal.
41. Spring seat.
42. Adjustment plates.
43. Terminal block.
44. Tail spring seat.
45. Mercury switches.
46. Overload-alarm thrust springs.
47. Adjustment bolt.
48. Adapter cylinder.

Figure 22. Dorr type-A clarifier.

D	W	M	Q	S	A
					14
2					
		9			
†					
				13	
		10			
3					
	17				
15					
				21	
		7			
		18			
			20		
		19			

c. INSPECT AND SERVICE TANK EQUIPMENT. Check all bolts and tighten nuts to maintain original alignments and adjustments on tank equipment.

Examine gears and all wearing parts for excessive wear. Keep machine and surroundings clean.

d. SERVICE SHEAR PINS. See paragraph 20.

e. CHECK MOTOR CONDITION. See paragraph 14.

f. CHECK COUPLINGS AND ALIGNMENT. See paragraph 19.

g. FLUSH SLUDGE LINE. Back-blow sludge line with high-pressure water or compressed air. Protect water connection against cross-connection hazards. See that sludge or foreign matter is not plugging sludge line.

h. CHECK TANK FOR SLUDGE OVERLOAD. If sludge overload is built up, open discharge line while machine is running. If the overload on motor is so great that heater coils in starter box cut out switch and stop machine, drain tank and sluice out sludge.

i. CAUTIONS. (1) When overload alarm rings bell or stops motor do not try to keep equipment running. Instead, find source of trouble and remove it immediately. Do not start equipment with load of sludge in tank. Do not tamper with overload-alarm-switch adjustments to keep machine running under overloaded conditions.

(2) If a foreign object drops into tank, stop machine and try to remove the object, if necessary cutting off influent to stop sludge accumulation. If object cannot be removed with tank filled, drain tank and remove object before resuming operation.

52. Dorr (Type W)

For illustration of a Dorr type-W clarifier, see figure 23.

a. INSPECT AND LUBRICATE REDUCERS. For proper lubricants, see paragraph 7 and table V.

b. LUBRICATE COUNTERSHAFT BEARINGS. The worm countershaft runs in two Oilite, bronze bushings of porous construction to absorb and retain oil. Add a few drops of OE 30 to oil cups over bushings to provide ample lubrication for shaft.

Drain and refill. Use NS 6135 in summer and NS 3080 in winter.

c. DRAIN MOISTURE FROM HOUSING. See paragraph 51*a*(3).

d. LUBRICATE ROLLER CHAIN. Chain guard is oiltight and dusttight and chain is lubricated by dipping into oil bath. Pour oil into guard through inspection opening in top until oil is level with small pipe plug in side of housing. Avoid overfilling which may cause leakage. Use NS 3065 in summer and NS 2075 in winter.

Open drain plug and draw off accumulated water. Check oil level, adding oil if necessary.

e. LUBRICATE GEARS AND BEARINGS. Check lubrication of worm, worm-gear, turntable bearing, shaft bushings, and ball thrust bearing, all lubricated by oil bath in housing. Check oil level by upstanding nipple on combination drain-and-overflow piping at side of worm chamber. Take out removable section of walkway to gain access to covered opening over worm; remove worm cover and overflow cap and inspect gears, then pour in oil slowly until it reaches top of overflow nipple. Replace cap and run machine for an hour or two before checking oil level again. The first few revolutions of the gear lubricates balls and races thoroughly. Use suitable heavy oils such as NS 6135 in summer and NS 3080 in winter.

W | M | Q | S | A

(1) *Check level.*

(2) *Drain and refill to proper level.* Too much oil may cause leakage over inner wall of gear housing.

22

14 *f.* INSPECT AND SERVICE TANK EQUIPMENT. See paragraph 51*c*.

9 *g.* SERVICE SHEAR PINS. See paragraph 20.

h. CHECK MOTOR CONDITION. See paragraph 14.

13 *i.* CHECK COUPLINGS AND ALIGNMENT. See paragraph 19.

10 *j.* FLUSH SLUDGE LINE. See paragraph 51*g*.

k. CHECK TANK FOR SLUDGE OVERLOAD. See paragraph 51*h*.

53. Dorr (Type SU)

For illustration of Dorr type-SU clarifier, see figure 24.

24 *a.* LUBRICATE ANNULAR BALL BEARING. See that oil in annular ball-bearing housing is level with top of overflow pipe under handhole cover. If oil level is low, add oil slowly through fill pipe while machine is operating, allowing time for oil to work around ball race. Use NS 3065 in summer and NS 2075 in winter.

26 Drain oil. Flush turntable with kerosene, and refill with fresh oil.

Note. A special pumping arrangement, requiring no attention by operator, is built into turntable-base casting to lubricate pinion and internal gear at point of contact.

23 *b.* LUBRICATE SPEED REDUCER (fig. 25). See that oil level is at proper mark on oil-level indicator. If oil is low, add NS 3080 in summer and OE 30 in winter.

25 (1) After every 2,000 hours of operation, drain oil through oil drain on back of unit and refill with new oil.

(2) Motor is factory lubricated and needs greasing only every 2 or 3 years. To lubricate, disassemble motor and repack it with grease.

Caution: When installing new unit, fill it with oil to proper level and change oil after first 100 hours of operation.

14 *c.* INSPECT AND SERVICE TANK EQUIPMENT. See paragraph 51*c*.

9 *d.* SERVICE SHEAR PINS. See paragraph 20.

e. CHECK MOTOR CONDITION. See paragraph 14.

13 *f.* CHECK COUPLINGS AND ALIGNMENT. See paragraph 19.

10 *g.* FLUSH SLUDGE LINE. See paragraph 51*g*.

h. CHECK TANK FOR SLUDGE OVERLOAD. See paragraph 51*h*.

54. Infilco Units (PD and WS Types)

For illustrations of Infilco clarifiers, types PD and WS, see figures 26 and 27.

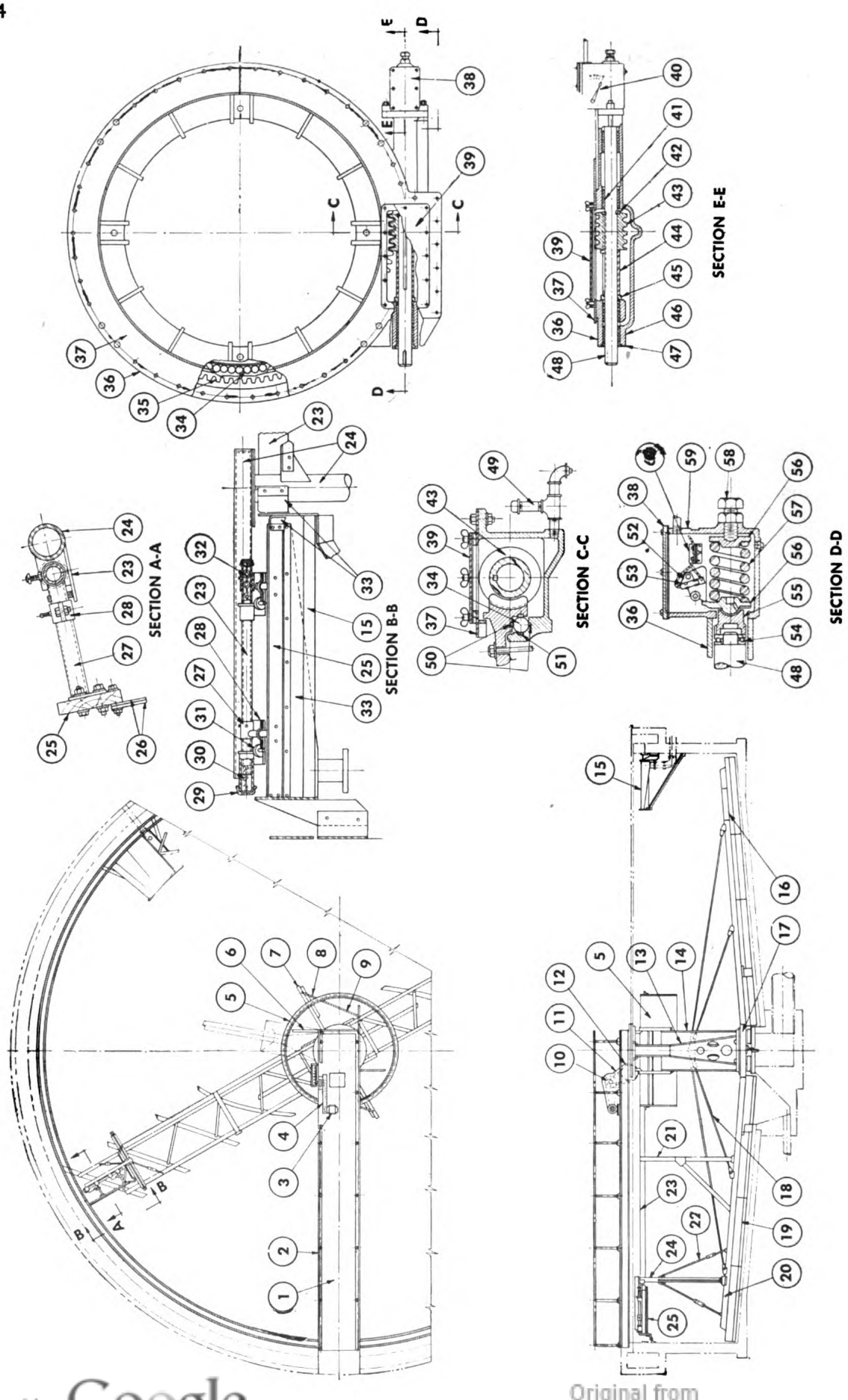
27 *a.* LUBRICATE CHAIN DRIVE. Check oil gauge to make sure oil level is visible, and add oil if necessary. To add oil, unscrew breather and fill chain-drive case with OE 30 to proper oil level; run motor for 10 minutes, then add enough oil to raise level to proper mark on gauge.

28 *b.* LUBRICATE MOTOR REDUCER. (1) Change oil in reducers which operate continuously. Use OE 10 in winter and NS 3050 in summer.

30 (2) Change oil in reducers which operate intermittently.

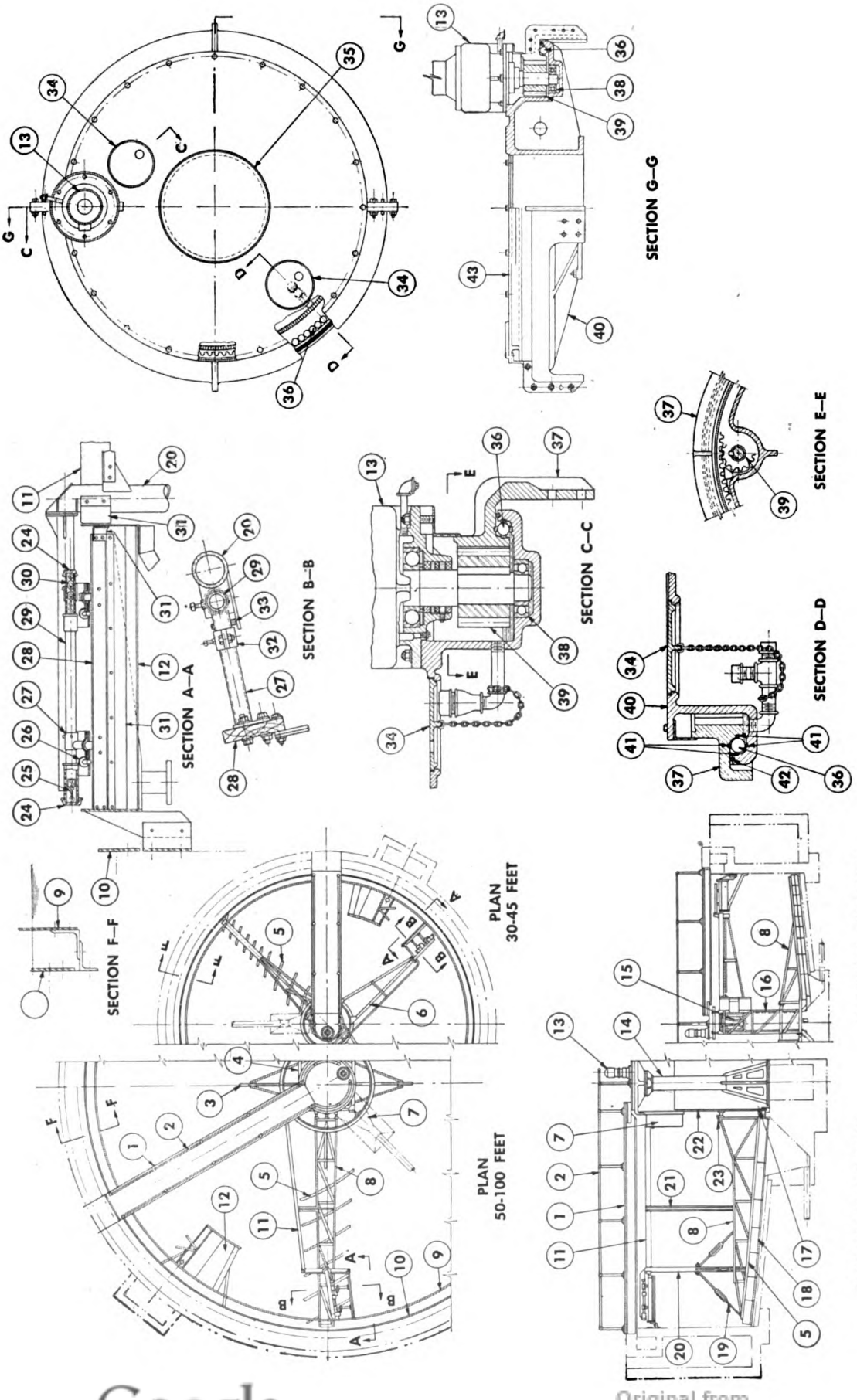
29 *c.* GREASE TURNTABLE AND DRIVE CASE. Use grease gun to force WB 2 into Alemite fittings on turntable and chain-drive case.

31 *d.* CHECK AND ADJUST CHAIN DRIVE. Remove top cover plate and examine chain drive. If chain is too slack loosen nut and turn idler sprocket until chain is taut. Leave slight sag or looseness on return run.



1. Mechanism support.
2. Handrail.
3. Motor.
4. Chain guard.
5. Influent well.
6. Influent-well support.
7. Drum blades.
8. Drum-blade support.
9. Drum-blade tie rod.
10. Drive sprocket.
11. Chain guard.
12. Driven sprocket.
13. Center support.
14. Center drum.
15. Scum trough.
16. Counterweight plates.
17. Rake-arm support.
18. Guy rods.
19. Squeegees.
20. Rake arm.
21. Skimming-blade support.
22. Guy rods.
23. Skimming blade.
24. Skimmer end support.
25. Skimmer blade.
26. Wiper.
27. Skimmer-blade bracket.
28. Clamp.
29. Pipe cap.
30. Spring.
31. Roller.
32. Cable coil chain.
33. Wiper.
34. Balls.
35. Worm-gear ring.
36. Gear housing.
37. Seal plate.
38. Overload-alarm housing cover.
39. Cover plate.
40. Pointer.
41. Bushing.
42. Thrust ring.
43. Worm.
44. Countershaft sleeve.
45. Set collar.
46. Bushing.
47. Oil seal.
48. Countershaft.
49. Oil fill and drain.
50. Upper and lower strip liners.
51. Inner strip liner.
52. Adjustment plate.
53. Mercury switch.
54. Inner strip liner.
55. Adapter cylinder.
56. Spring seat.
57. Thrust spring.
58. Adjusting belt.
59. Overload housing.
60. Terminal block.

Figure 23. Dorr type-W clarifier.



1. Mechanism support.
2. Handrail.
3. Drum blade.
4. Influent-well support.
5. Rake blade.
6. Skimmer truss.
7. Influent well.
8. Rake arm.
9. Scum baffle.
10. Weir plate.
11. Skimmer blade.
12. Scum trough.
13. Motor.
14. Center support.
15. Diffuser.
16. Center cage.
17. Lower hinge.
18. Squeegee.
19. Guy rod.
20. Skimmer end support.
21. Intermediate support.
22. Center drum.
23. Upper hinge.
24. Pipe cap.
25. Spring.
26. Roller.
27. Skimmer-blade bracket.
28. Skimmer blade.
29. Bracket support.
30. Cable coil chain.
31. Wiper.
32. Clamp.
33. Roller.
34. Handhole cover.
35. Center cover.
36. Roller balls.
37. Internal gear.
38. Ball bearing.
39. Pinion.
40. Gear housing.
41. Strip liner.
42. Felt packing.
43. Gear-housing cover.

Figure 24. Dorr type-SW clarifier.

W	M	Q	S	A
				*
	9			
			13	
	10			

e. REMOVE SLUDGE OVERLOAD. During prolonged shutdown, sludge may settle and pack. When this happens, loosen packed sludge with hose or other means before starting motor again.

Caution: Do not tamper with adjustable spring inside torque overload device, which is set at factory for maximum permissible torque.

f. SERVICE SHEAR PINS. See paragraph 20.

g. CHECK MOTOR CONDITION. See paragraph 14.

h. CHECK COUPLINGS AND ALIGNMENT. See paragraph 19.

i. FLUSH SLUDGE LINE. See paragraph 51*g*.

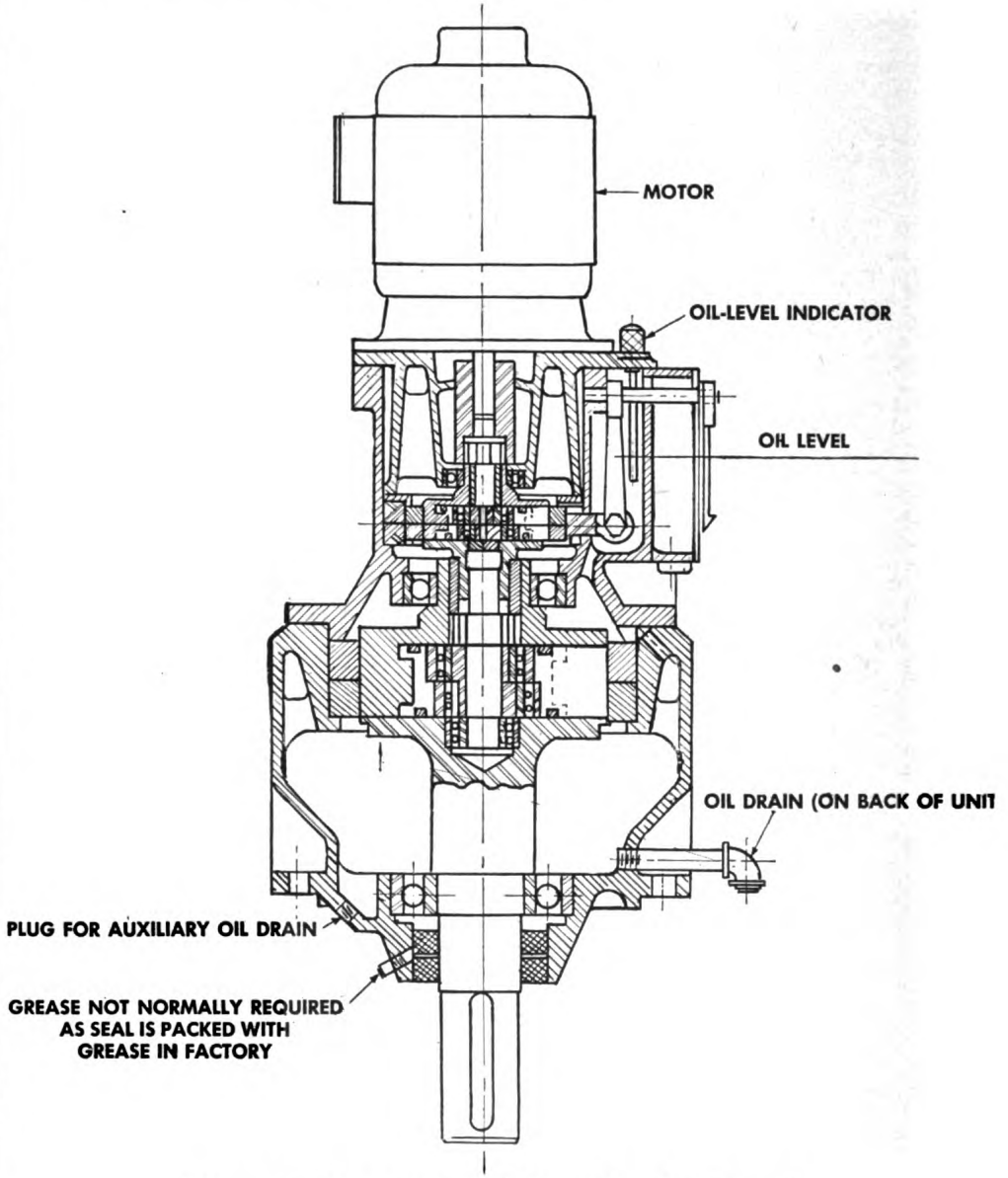


Figure 25. Dorr type-SU heliocentric reduction unit.

55. Link-belt Circuline Units (A and B Types)

For illustration of revolving type circuline clarifier, see figure 28.

			37	

a. INSPECT EQUIPMENT. Drain tank completely. Check for excessive wear and breakage in all working parts which are normally submerged. Inspect electric-current-collector rings and pivot bearings on center column. If

D	W	M	Q	S	A
			36		
	33				
	34				
	35				
32					
†					
					39
	38				
†					
40					
					42
					43
41					
†					

repairs are necessary, request services of an electrician. Lubricate current-collector rings and fingers with vaseline or with CG 0 in winter and CG 1 in summer.

b. CHECK OIL LEVEL AT CENTER BEARING. Add NS 5190 or NS 6135 if necessary.

c. CHECK OIL LEVEL IN REDUCER. Use NS 3065 oil for herringbone and motorized reducers. Lubricate worm gears with NS 3080 in winter up to 40° F. and NS 6135 above 40° F.

d. GREASE BEARINGS AND MOVABLE PARTS ABOVE WATER LEVEL. Use BR grease.

e. GREASE GEARS AND CHAIN DRIVES. Lubricate roller chains with OE 30, NS 3080, or CW 2 lubricant.

f. CHECK ICE FORMATION AND LUBRICATE COLLECTOR CHAINS. Before starting collector equipment in extremely cold weather, make sure ice has not frozen tow chain to pocketed wheel. If chain has frozen to pockets, remove guard and pry chain loose with a bar. Use discarded crankcase oil on tow chain and on chains operating from driving mechanism into sewage.

g. CHECK MOTOR CONDITION. See paragraph 14.

56. Chain-Belt Units (Tow-bro Type)

a. CHANGE OIL IN REDUCER. Use lubricants listed in paragraphs 51 and 52.

Caution: When reducer is first installed, fill with oil to proper level and change oil after first month of operation.

b. CHECK OIL LEVEL IN REDUCER. If there is water in the oil, drain oil completely, flush, and refill with new oil. When reducer runs hot, check oil level; too much or too little oil may be the cause. If reducers are taken out of service for a long period, fill them completely with oil to prevent oil seals from drying out.

Caution: Do not lubricate Eel-slip type underwater bearings.

c. CHECK MOTOR CONDITION. See paragraph 14.

57. Yeoman's-Simplex Type Units

a. LUBRICATE REDUCTION GEAR. (1) Fill reduction-gear case with oil before operating and keep it filled to top of gauge pipe. Measure oil level when equipment is not operating. Use NS 3080 for ordinary temperatures and OE 30 for temperatures below 50° F.

(2) Drain case completely and refill with fresh oil.

(3) Add 1 cup of CG 1 grease in summer and 1 cup of CG 0 in winter to all grease cups and Alemite fittings.

b. LUBRICATE ROLLER THRUST BEARING. To lubricate roller thrust bearing which supports main driveshaft, add grease through the ¼-inch pipe connection with Alemite fitting which is on side of gear-reducer support housing. Keep bearing filled with BRB No. 4 grease.

c. CHECK MOTOR CONDITION. See paragraph 14.

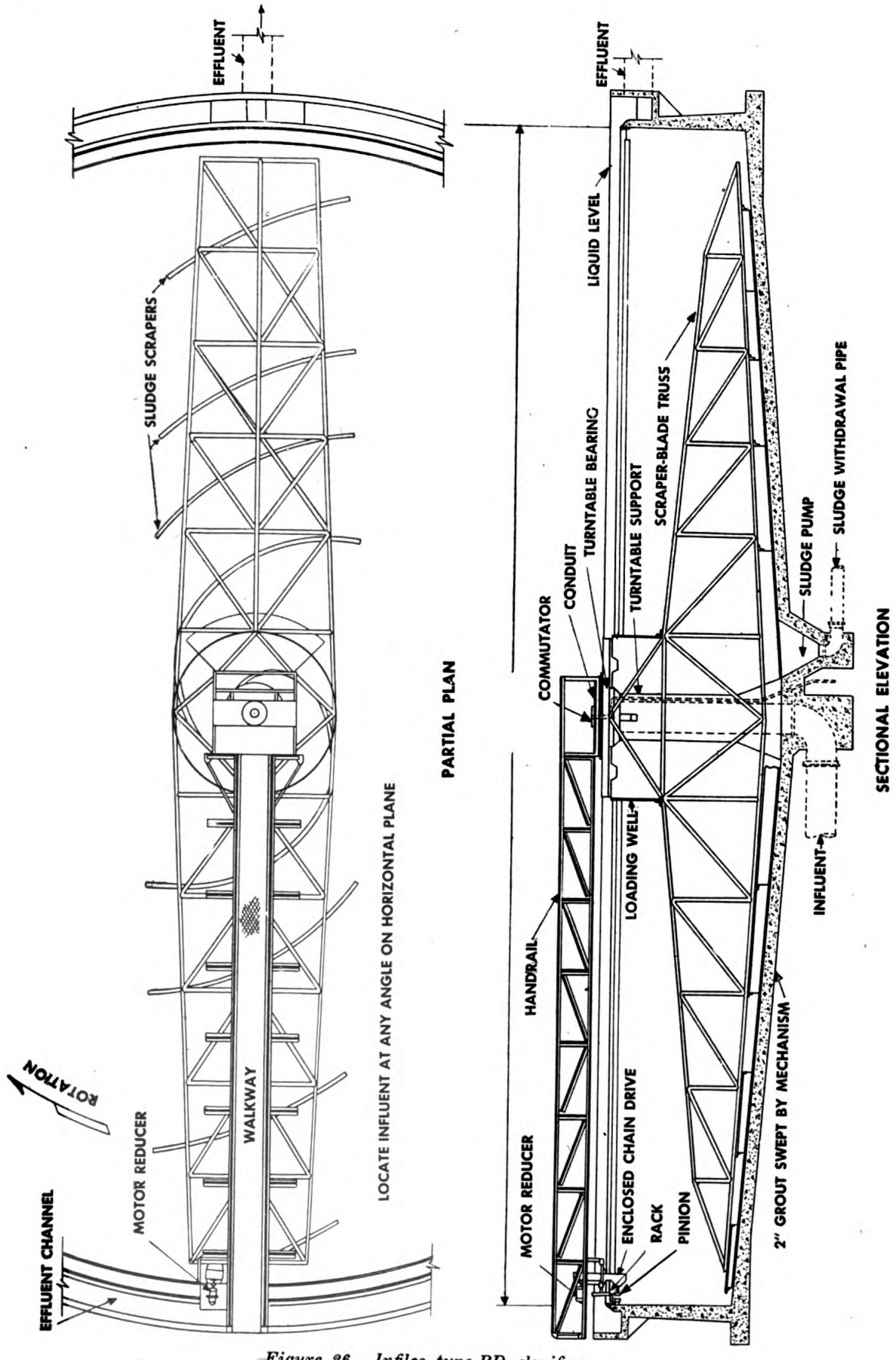


Figure 26. Infilco type-PD clarifier.

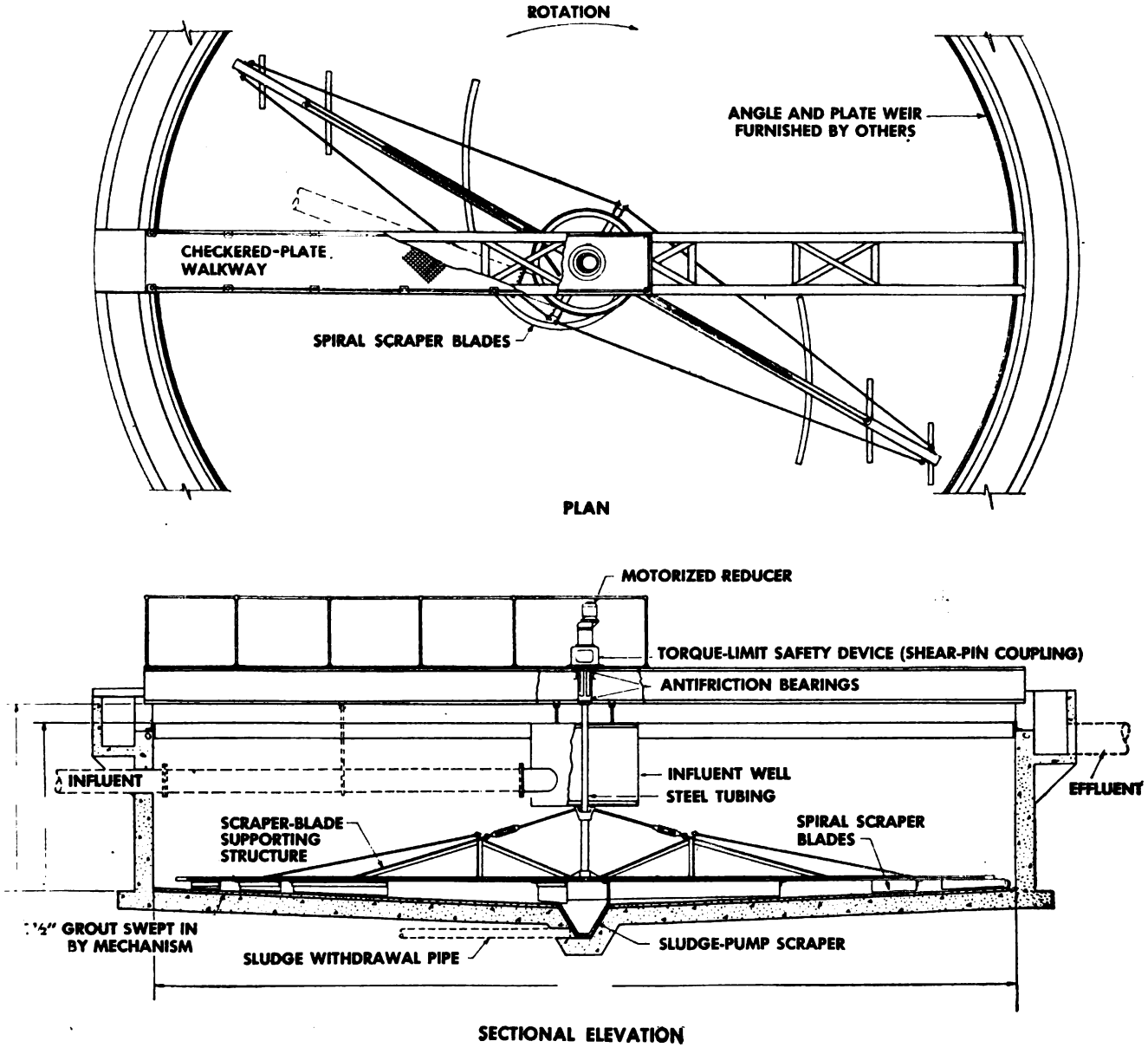


Figure 27. Infilco type-WS clarifier.

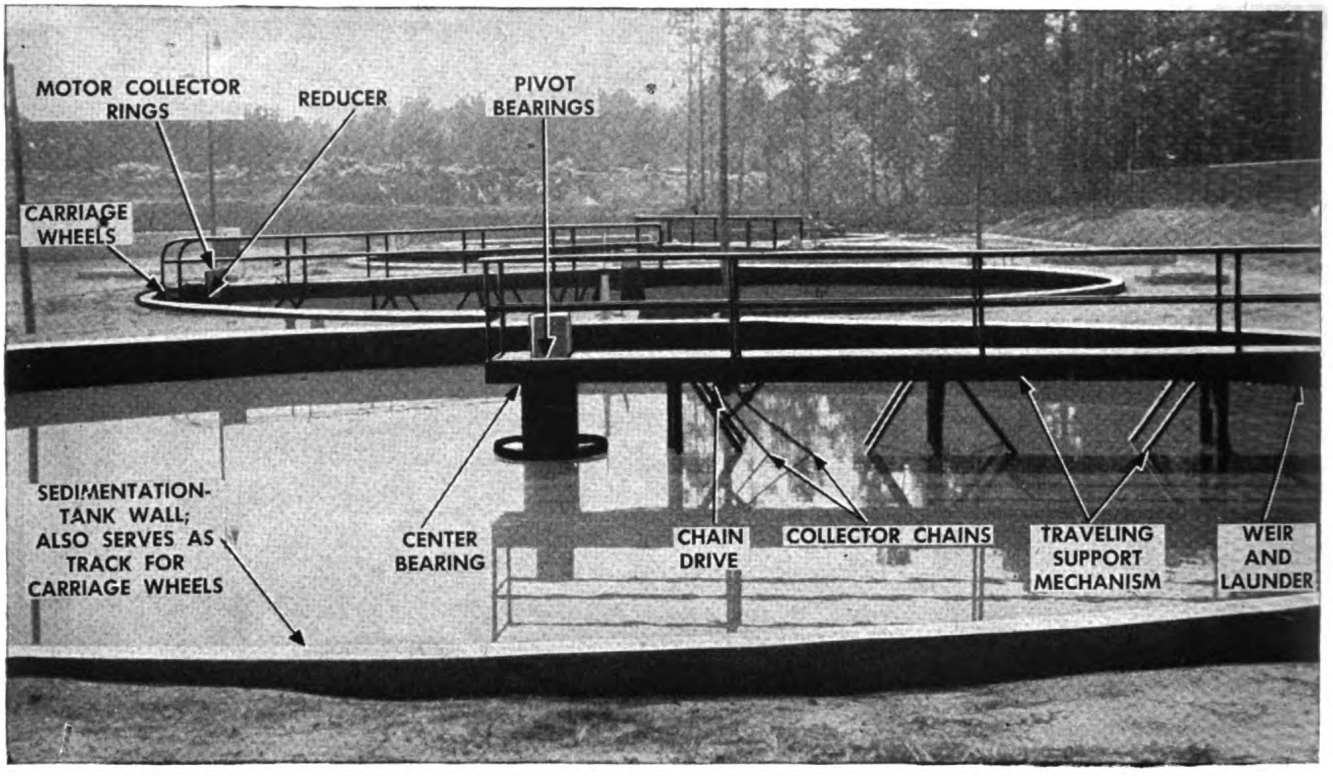


Figure 28. Revolving type circuline clarifier.

SECTION XI

SEDIMENTATION-TANK EQUIPMENT (CONVEYOR TYPE)

58. American Well Works Type Equipment (fig. 5)

D	W	M	Q	S	A
	1				
				5	
	2				
	3				
	4				
				6	
				7	
				8	
				9	

a. CHECK OIL LEVEL IN REDUCER. Check oil level in reduction unit when unit is not operating to see that oil is level with petcock installed on side of unit, or with level indicated on unit.

Change oil for summer and winter lubrication. See paragraph 7 and table V for proper lubricants.

b. GREASE SPROCKET ASSEMBLY. Grease insert on drive sprockets of output-reducer shaft with WB. This keeps sprockets from binding to shaft, thus losing protection provided by shear pin.

c. OIL DUAL-DRIVE JAW CLUTCHES AND BEARINGS. Disengage jaw clutch from jaw coupling, putting one unit out of service. Reverse unit momentarily to relieve stress against jaws and slide clutch along shaft until jaws are completely disengaged. Be sure shafting is clean so jaw clutch does not bind to shaft. Oil shaft with OE 50, or a lighter oil in winter, to facilitate moving the clutch and to make sure jaw is not stuck.

d. GREASE PILLOW-BLOCK BEARINGS. Grease pillow-block bearings until grease squeezes out at the ends. Use WB.

Caution: Do not lubricate underwater bearings except when unit is taken out of service and emptied.

e. INSPECT FLIGHTS. See paragraph 59*a*.

f. SERVICE DRIVE CHAIN. If drive chain is slapping because of loose fit, remove a link from chain or raise drive unit by putting additional shims beneath it. When resetting drive unit, use plumb bob to insure vertical alignment of drive sprocket on reducer shaft and sprocket on head shaft.

g. GREASE DRIVE CHAIN. Grease drive chain in cold climates to prevent freezing which causes chain to jump or break. Use heavy CW 2, which sticks to chain for months and eliminates any kinking.

h. TIGHTEN CHAINS. See paragraph 61*a*.

59. Chain-Belt Rex Equipment (MI and ME Types)

D	W	M	Q	S	A
				6	
				11	
		10			

a. INSPECT FLIGHTS. Inspect wood flights for cracks and make sure they are securely fastened to attachments. If bolts are loose, tighten rivet and peen end of bolt so nut cannot work loose. Weld Stellite to steel wearing shoes to prolong their usefulness.

b. INSPECT DRIVE CHAIN AND SPROCKET. See paragraphs 17 and 43*d*.

(1) Chains usually deteriorate when not used for long periods. If chain is to be idle long, remove it, coat with heavy lubricant or corrosion preventive, and store until needed.

(2) Replace damaged links promptly to prevent unnecessary wear on adjacent links and sprockets.

c. LUBRICATE REDUCER. Drain and flush reducer-gear case. In normal ambient temperatures ranging from 50° F. to 100° F., use NS 5150. In

Abbreviations: D, means daily; W, weekly; M, monthly; Q, quarterly; S, semiannually; A, annually.

low ambient temperatures ranging from –10° F. to plus 50° F., use NS 3080.

d. CHECK MOTOR CONDITION. See paragraph 14.

60. Jeffrey Type Equipment

a. LUBRICATE SPEED REDUCER. Check oil level in speed reducer and add oil as needed. Do not fill reducer above specified oil level. Always check level with reducer idle.

Change oil in reducer. Use NS 6135 above 40° F. and NS 3080 below 40° F.

b. LUBRICATE BABBITTED LINE-SHAFT BEARINGS. Lubricate babbitted line-shaft bearings with WB 2, added through Alemite grease fittings or other means. In extremely dusty areas, grease bearings more frequently. Keep all bolts and bearing caps tight.

c. INSPECT AND LUBRICATE ANTIFRICTION LINE SHAFT BEARINGS. Inspect roller or ball bearings on line shafts to see that collars on each end of bearings are tight, keeping sleeves from moving on shaft. Do not fill grease pocket around roller or ball bearings more than two-thirds full. Use BR grease.

d. INSPECT UNDERWATER BEARINGS. Do *not* lubricate bearings submerged in sewage. Before starting equipment in which bearings have dried, lubricate bearings with OE 10. Inspect bearings to see that all bolts are tight and that bearings are properly secured to tank walls.

e. INSPECT COLLECTOR CHAINS. Inspect main collector chains to make sure proper slack is maintained.

f. INSPECT AND REPLACE WEARING SHOES. Inspect wearing shoes on flights, replacing them or welding Stellite to bottoms.

g. INSPECT AND LUBRICATE HINGED FLIGHTS. Use WP grease.

h. ADJUST AND LUBRICATE TIGHTENER. Keep drive chains to drive sprockets fairly tight by adjusting chain tightener. Lubricate with CW 3.

61. Link-Belt Equipment (Straightline Type)

For illustrations of link-belt straightline collector, see figures 29 and 30.

a. TIGHTEN CHAINS. With take-up shaft (Nos. 13 and 16, fig. 29) in extreme forward position, stretch chains in primary tank tightly around sprockets, and remove any excess links. In final tanks where take-ups are not used, place chains around sprockets and remove links until chains become tangent with guide angles for return run.

b. LUBRICATE SPEED REDUCER. Follow lubrication instructions attached to unit. See paragraph 7 and table V for lubricants.

(1) Check oil level in reducer oil gauge. (See fig. 31.)

(2) Change oil.

c. GREASE BEARINGS AND SPROCKETS. Apply WB 2 grease to drive sprocket, to all bearings above water level, and to movable parts. If aluminum shear pin in driving sprocket breaks or overload switch throws out, determine and remedy trouble before starting collector again.

d. GREASE GEARS AND CHAIN DRIVES. See paragraph 7 and table V for proper lubricants.

e. CHECK MOTOR CONDITION. See paragraph 14.

D	W	M	Q	S	A
		20			
				22	
	18				
	19				
		21			
17					
†					

62. Dorr (Monorake Type)

a. ADJUST DRIVE CABLE. If slack in drive cable becomes excessive, correct by adjusting take-ups at opposite end of tank from drive unit. In general, keep cable slack rather than tight to keep wear on cable and mechanism to a minimum. On cables which are not submerged during operation, make necessary adjustment to compensate for difference in cable length caused by winter and summer temperature changes.

b. CHANGE OIL IN DRIVE HOUSING. Oil bath in drive unit housing lubricates all gears and input and worm-shaft bearings. Change oil to meet seasonal requirements, using NS 6135 in summer and NS 3080 in winter. To get at oil bath, remove inspection cover over spur gears or take out pipe plug in switch cover. Make sure oil level is about at center of worm shaft, and level with top of overflow nipple on the drain piping.

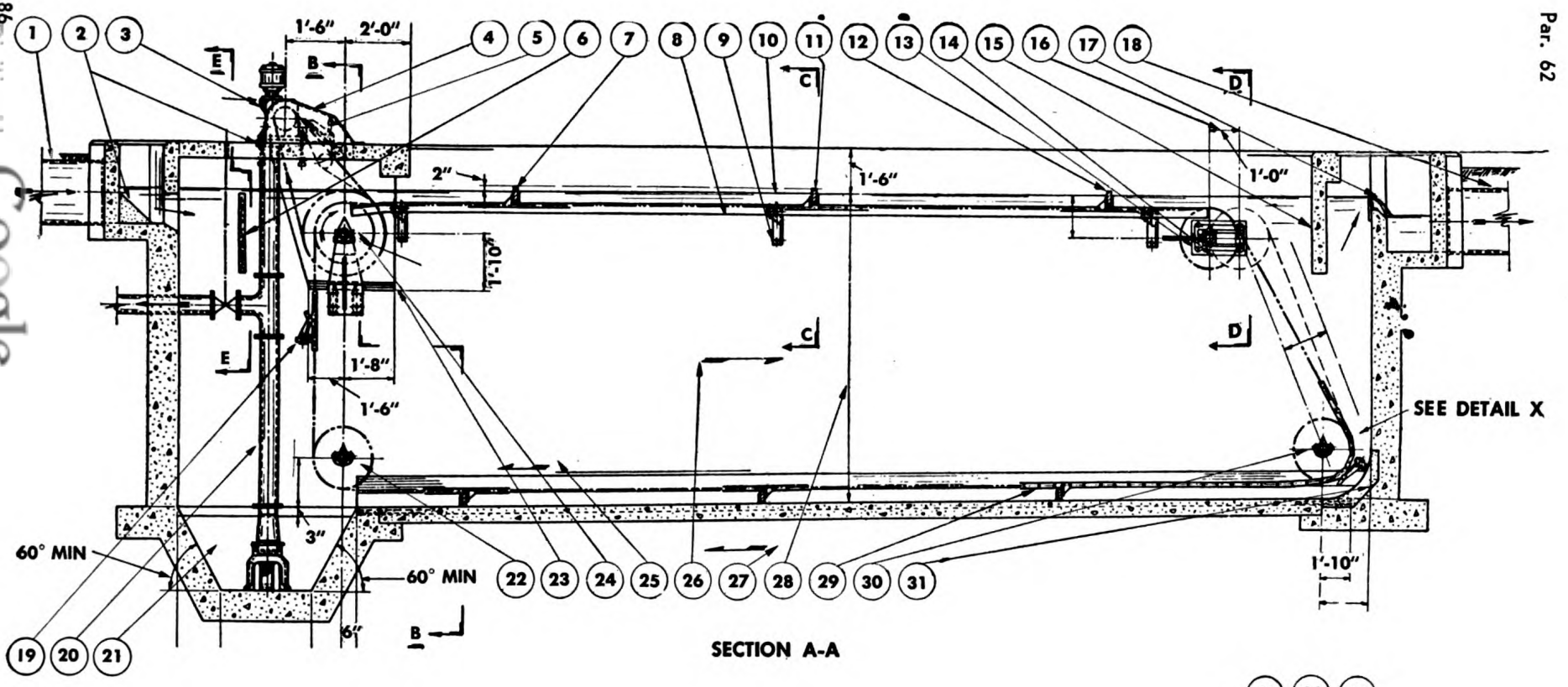
c. GREASE BEARINGS. Lubricate the four drive-sheave bearings sparingly with BR grease, added through grease pipes and Alemite fittings on side of drive housing. Use BR grease to lubricate bearings on carriage wheels, control shaft, and large drive-rope guide sheaves located at tank corners.

d. LUBRICATE BUSHINGS. All smaller guide sheaves and rollers, control-sheave hooks, limit-switch sheaves, and pins have Oilite bushings of porous bronze which soaks up and retains a large amount of oil. These bushings do not have any oil holes because oil penetrates them readily. Squirt a few drops of OE 10 into the small oil cups at each of these points to keep bushings saturated. Bushings at rake-arm pivots are graphited bronze and require no further lubrication.

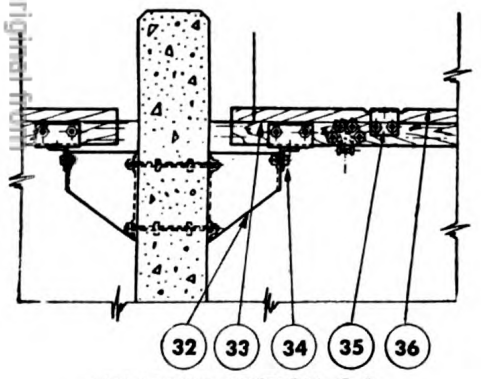
e. INSPECT OIL BATHS. Inspect all oil baths regularly for proper oil level. Drain off small amount of oil to draw off accumulated water. Sample oil for body, oiliness, and grit, and change oil promptly if necessary.

f. GREASE SCREW CONVEYOR BEARINGS. Bearings on screw conveyor are fitted with grease piping brought to top of tank. Lubricate these bearings with BR grease.

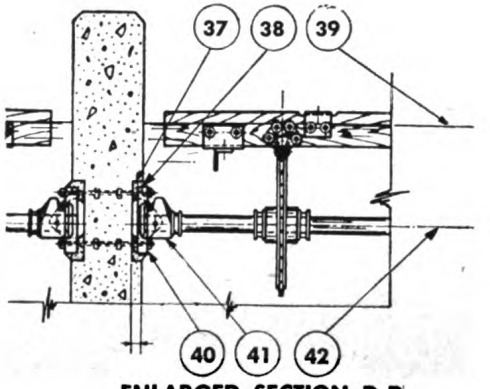
g. CHECK MOTOR CONDITION. See paragraph 14.



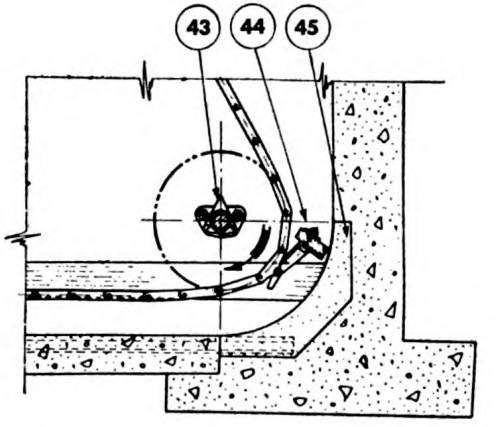
SECTION A-A



ENLARGED SECTION C-C



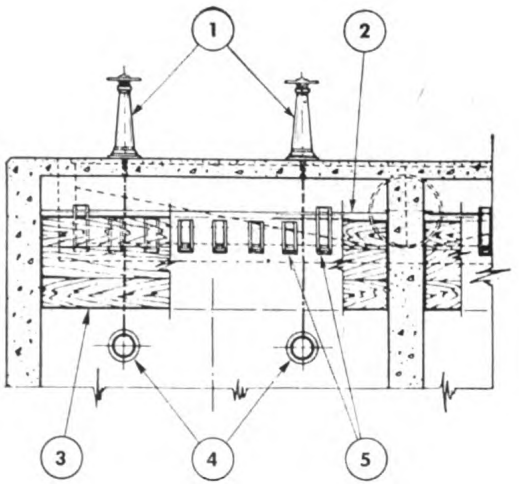
ENLARGED SECTION D-D



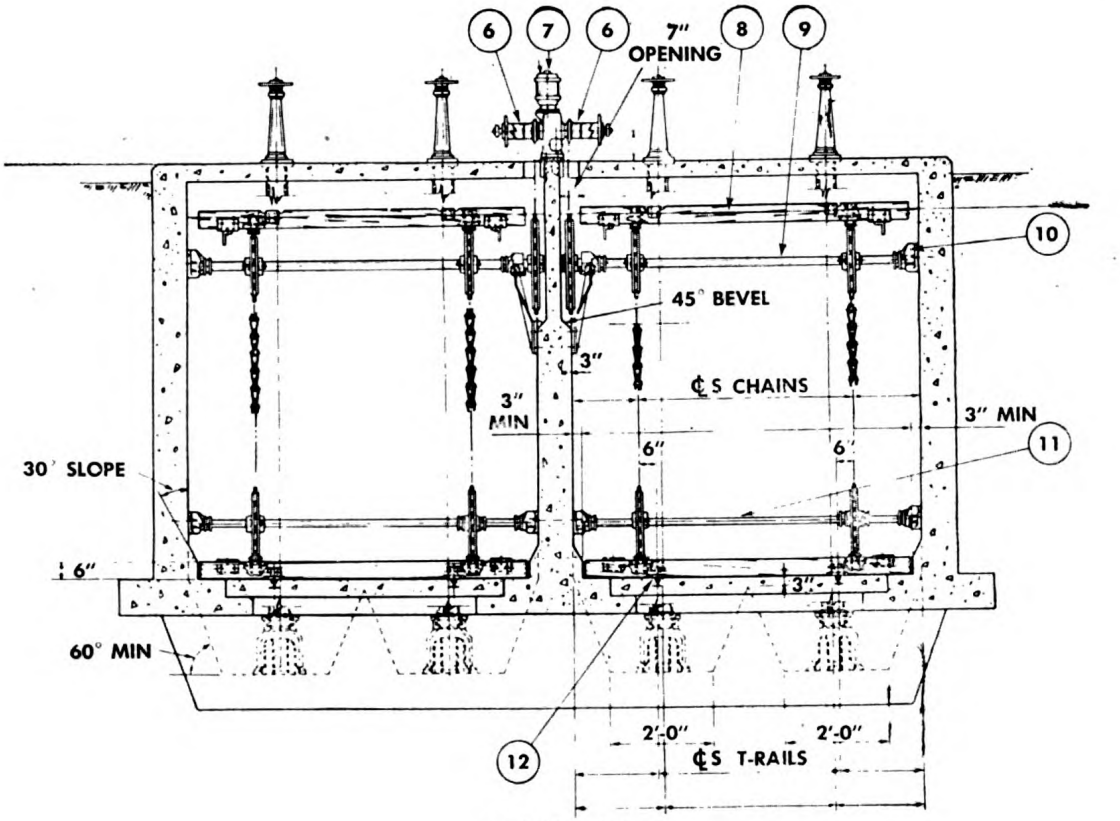
ENLARGED DETAIL X

1. Influent.
2. Grout.
3. Drive unit.
4. Chain guard.
5. Chain tightener.
6. Baffle.
7. Rigid flight.
8. Return-run flight.
9. Bracket.
10. Water level.
11. Wood flights 1¾" x 5⅝" spaced on approximately
12. 10' centers.
13. Take-up shaft.
14. Recess for take-up bearing frame.
15. Scum baffle.
16. Take-up movement.
17. Adjustable effluent weir.
18. Effluent.
19. Pivoted flight.
20. Sludge withdrawal pipe.
21. Sludge hopper.
22. Front turn shaft.
23. Recess for chain drive.
24. Head shaft.
25. Collector (travels 2 fpm).
26. Flow.
27. Floor (slopes approximately 1%).
28. Average water depth.
29. Collector chain.
30. Back turn shaft.
31. Grout.
32. Steel bracket.
33. Water level.
34. Track angle.
35. Wearing shoes.
36. Wood flight.
37. Recess for take-up frame.
38. Grout.
39. Water level.
40. Take-up frame.
41. Take-up bearing.
42. Shaft.
43. Back turn shaft.
44. Pivoted flight.
45. Grout.

Figure 29. Link-belt straightline collector.



SECTION E-E



SECTION B-B

1. Floor stands.
2. Water level.
3. Baffle.
4. Sludge withdrawal pipes.
5. Influent ports.
6. Pin hub and clutch.
7. Drive unit.
8. Water level.
9. Head shaft.
10. Peak cap bearing.
11. Front turn shaft.
12. Floor screeded level and smooth with tops of 25 pound T-rails.

Figure 30. Straightline collector, cross section.

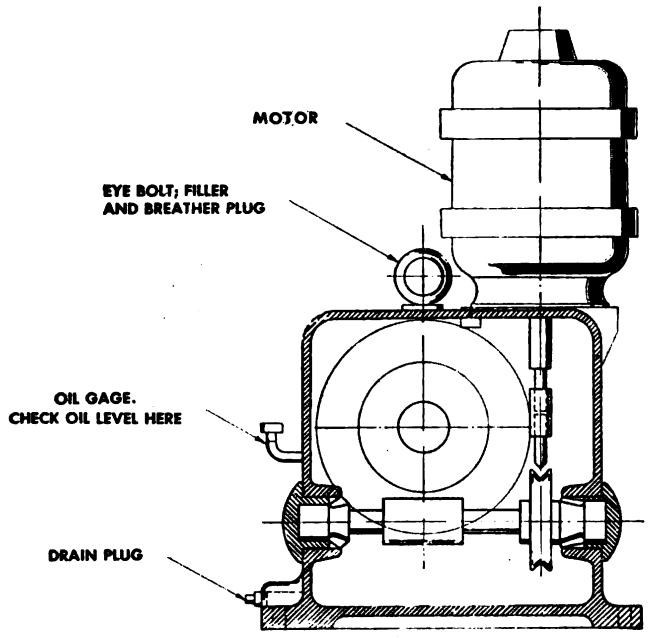


Figure 31. Link-belt double-worm-gear reducer.

SECTION XII

TRICKLING FILTER EQUIPMENT (REVOLVING DISTRIBUTORS)

D	W	M	Q	S	A
1					
2					
				3	
¼					
				9	

63. General

a. CLEAN JETS. Inspect spreader jets, splash plates, or orifices and clean if necessary.

b. FLUSH ARMS. After cleaning orifices, flush out distributor arms by gate at end of each arm or by punching orifices clean while flushing.

c. ADJUST ARMS. (1) In hot weather, take up on turnbuckles of vertical guy rods slightly when necessary to prevent arms from coming too close to surface of stone. If spreader jets are used, operate them with hinged flap down to distribute sewage more evenly.

(2) In cold weather, adjust turnbuckles as necessary to prevent arms from being higher at outer end. In extremely severe weather, leave shear gates at ends of arm partly open to drain distributor arm between doses of siphon. Turn hinged flaps of spreader jets up against pipe to minimize ice formation around these parts. Keep arms level or sloped slightly downward from center of bed. In adjusting, balance all arms exactly by measuring to a mark on filter wall.

Caution: Take necessary precautions to prevent extreme surges through distributor, which may blow the mercury seal into the trap. See paragraph 64*h*.

64. American Well Reaction- and Motor-Driven Type Units

a. PERFORM GENERAL MAINTENANCE. See paragraph 63.

b. CHECK AIR-RELIEF PIPE. Keep air-relief pipes open at all times. Screw air-relief unit loosely into tapped hole for easy removal or adjustment. Poor distribution results from clogged relief pipes because arms become air-locked, preventing proper flow to outer orifices. In cold climates, direct the flow from outer air-relief pipe to intersection of rock and filter wall, where continuous stream of sewage will minimize formation of ice. If removal of end section of pipe arm is necessary to permit cleaning entire arm with a brush, block up each arm firmly at several places and relieve load on all trusses simultaneously before removing end section.

c. LUBRICATE OIL SEAL AND GUIDE BEARING. Use NS 5150 or CG 1 for seal. Add oil to machine with a grease gun, after temporarily removing air-release plug. Pump one gun of oil into upper pressure fitting of seal. Under low head conditions slight oil or water seepage from top oil seal is permissible and does not harm guide-bearing ring.

d. FLUSH OUT BLOWOFF PLUG. Remove lower blowoff plug and wash out sediment with a hose or by flow of sewage. After plug is put back, replace oil.

e. LUBRICATE MAIN THRUST BEARING. Lubricate main thrust bearing on top of center column by pumping about half a grease gun of NS 5150 into bearing.

Abbreviations: D, means daily; W, weekly; M, monthly; Q, quarterly; S, semiannually; A, annually.

D	W	M	Q	S	A
			8		
				10	
		7			
				11	
†					
		14			
				21	

f. CHECK FREEZEOUT PLUG. If wooden freezeout plug is forced out, replace it before starting operation. This plug does not protect machine when water below seal freezes solid, which occurs when machine is idle for a long period. If machine is to be idle for long in cold weather, drain water from unit through blowoff plug.

g. SERVICE MERCURY SEAL. Distributors equipped for mercury seal have an annular mercury well between stationary column and rotating section. If the seal is accidentally blown, mercury is caught in a trap at guide ring just below the manifold. To withdraw mercury from this well, remove plug provided and catch mercury in a glass container. Do not catch mercury in a pan or can with soldered joints because mercury amalgamates with solder, destroying the joints. Replace mercury in annular space between support section and manifold. Pour it through a small funnel inserted in a rubber tube long enough to reach the annular well from outside the handhole cover.

h. CHECK FOR EXTREME SURGES. Prevent surges through the distributor, which result from sewage building up momentarily to a height above the arms, causing a greater head than the machine is designed to handle. An extreme surge may blow the mercury seal into the trap, causing unnecessary trouble and expense if any mercury is lost.

If a mercury seal is blown, check for source of trouble which may be clogged orifices, unusually large quantity of sewage entering plant, or improperly adjusted surge chamber. If sewage is pumped directly to distributor with no surge chamber provided, initial surge may blow the mercury seal. In such cases, turn down valve on discharge side of pump to decrease volume of water pumped to distributors.

i. CHECK BRUSHES AND CLEAN COLLECTOR RINGS ON MOTOR-DRIVEN TYPE. Before starting work on brushes or collector rings, disconnect main power switch for distributor. Remove electrical contact brushes located in housing around clutch and collectorring assemblies and clean them with emery cloth to remove grime; this improves electrical contact and insures smooth motor operation. If brushes are badly worn, have an electrician replace them with new brushes. Clean collector rings with emery cloth.

j. CHECK MOTOR CONDITION. See paragraph 14.

65. Chain-Belt Reaction and Motor-Driven Disc Type Units (figs. 32 and 33)

a. LUBRICATE CENTER-COLUMN BEARING. The bayonet type oil gauge (No. 6, fig. 32) screwed into top of bearing cap is marked to indicate minimum oil level for bearing chamber. Fill bearing chamber with oil that does not thicken at lowest prevailing temperature. In most sections OE 10 is satisfactory. Check oil level in bearing chamber.

b. INSPECT OIL. Inspect condition of oil in chamber. Drain and replace with fresh supply if necessary. Change oil as follows (key numbers refer to fig. 32) :

(1) Block up outer end of all branches to relieve strain on bearing.

(2) Remove bearing cap (7), unscrew cap screws (9) which fasten bearing housing (8) to inner column (5), and remove bearing housing.

(3) Pour out oil and wash and clean entire bearing assembly.

(4) Reassemble; before replacing bearing cap, make sure no dust or other foreign material has entered bearing.

D	W	M	Q	S	A
			19		
					25
				22	
		15			
				23	
12					
				24	
			20		

c. LUBRICATE GUIDE ROLLERS. Turn down grease cups (14) about one full turn. Refill grease cups when necessary with WB 2, which does not get too stiff at low temperatures.

d. CLEAN GUIDE ROLLERS. Remove guide rollers (13) from brackets and clean thoroughly.

e. ADJUST GUIDE ROLLERS. Check that there is a clearance of 0.005-inch between all guide rollers and the machined flange they bear against. Adjust clearance if necessary.

(1) To adjust guide rollers, loosen cap screws (11) which fasten guide-bearing bracket and loosen jam nut on adjusting screw (10). Turn adjusting screw slightly, tighten cap screws, and check clearance. Continue until 0.005-inch clearance is obtained.

(2) If faces of rollers show excessive wear, check that arms and branches of distributor are absolutely level.

f. CHECK MERCURY SEAL. Make sure mercury seal at bottom of center column is filled to level shown (2). If mercury is low, inspect base of column for leaks.

(1) Before pouring mercury into seal, place receptacle under inlet to catch spillage. See that drain plug (1) is tight. Then remove plug from mercury inlet (12) and pour mercury through a funnel to indicated level.

(2) If a sudden surge forces mercury from seal into circular mercury trap (4) above mercury inlet, reclaim mercury by opening drain plug (1) in bottom of mercury trap and catching mercury in a container.

g. SERVICE MERCURY SEAL. (1) Place receptacle under drain plug (1), open plug, and drain mercury from seal. Flush seal thoroughly with a garden hose attached to mercury inlet.

(2) Wash drained mercury before pouring it back into seal. Place it in a container with a tight lid, such as a clean paint can without soldered joints, add water, shake vigorously, and then decant water. Repeat until mercury is clean.

(3) To remove any grit, place mercury on dampened chamois skin; water passes through chamois and grit particles adhere to chamois when mercury is poured off. Repeat procedure several times if necessary.

(4) If mercury has become badly sludged, dissolve grease with kerosene, then treat with 50 percent concentrated solution of nitric acid and wash with sodium bicarbonate solution to neutralize acid. After two or three washings in water, mercury is ready for use.

h. INSPECT AND SERVICE DISTRIBUTOR NOZZLES. To clean nozzles, unscrew orifice cover (fig. 33) and remove any debris. Before replacing orifice cover, apply a little grease or Tite-Seal compound (furnished with equipment) to threads to prevent leakage.

i. INSPECT POSITION OF DISTRIBUTOR ARM AND BRANCHES. Check to see that distributor arms and branches are level when column is plumb. If arms and branches are dismantled from center column, replace them in their original position because no two arms or branches are alike. After distributor nozzles are set to give proper distribution to bed, do not disturb them.

j. INSPECT, CLEAN, AND LUBRICATE BLOWER. Remove hood and inspect front bearing of fan. Lubricate with BR grease. If fan wheel is coated with grease or dirt, clean it to keep fan wheel from becoming unbalanced and causing wear on rear bearing.

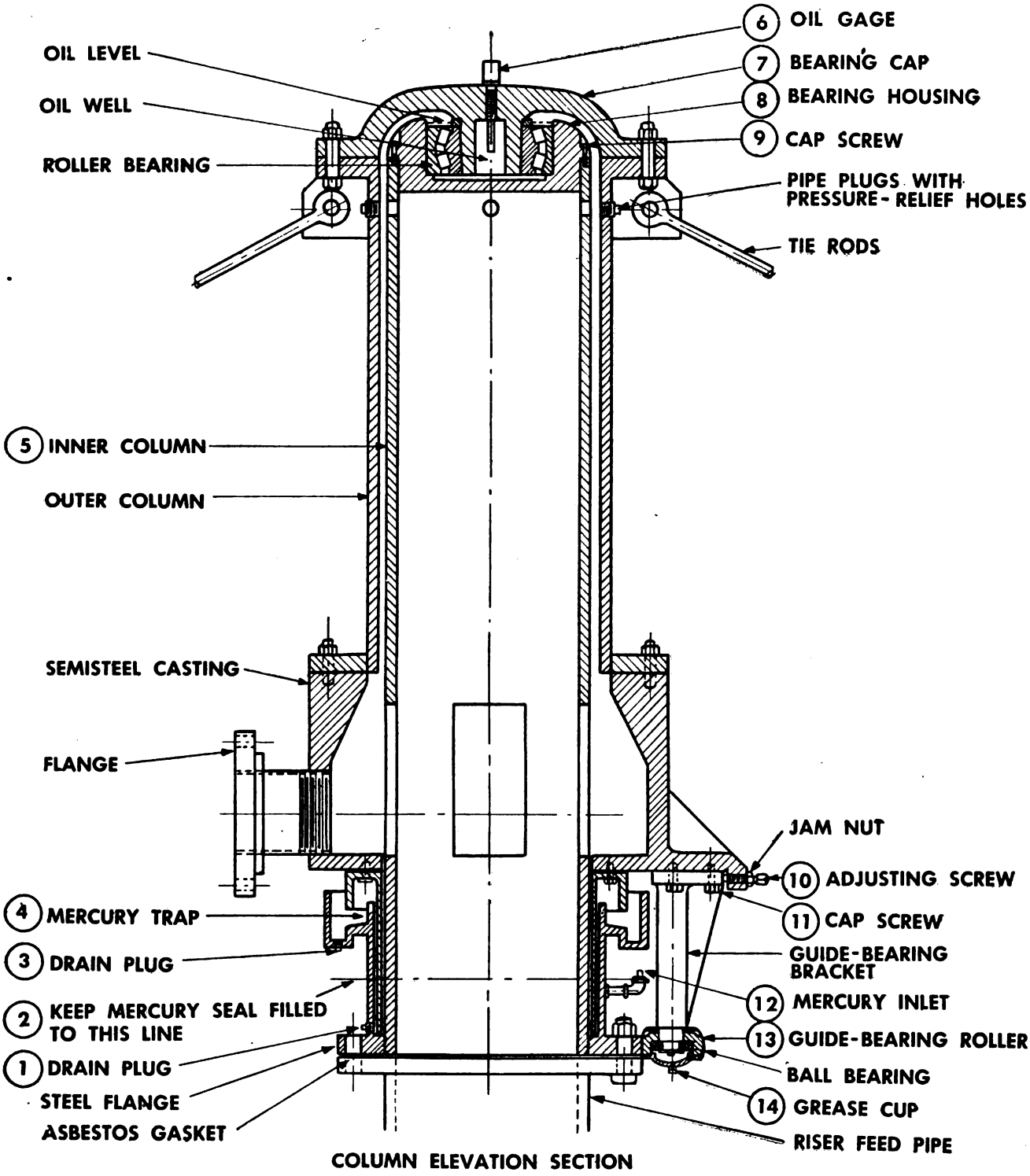


Figure 32. Chain-belt rotary distributor.

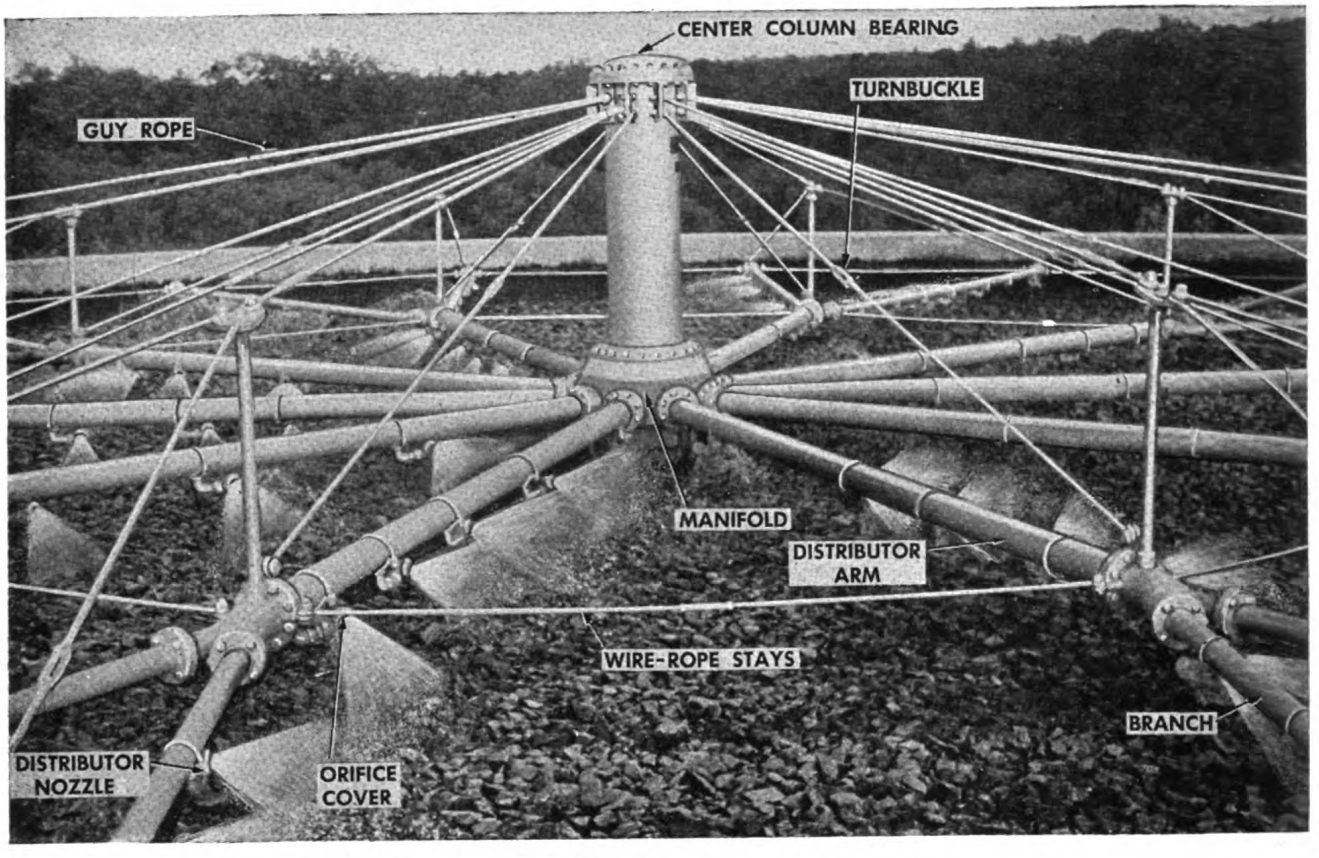


Figure 33. Chain-belt distributor for aerofilter.

D	W	M	Q	S	A
		16			
	13				
		17			
		18			

k. LUBRICATE SPEED REDUCER ON MOTOR DRIVEN DISC TYPE UNIT. Use oils listed below:

(1) For reducers operated in normal ambient temperatures from 50°F. to 85°F., use NS 5150.

(2) For operation in high ambient temperatures from 85°F. to 115°F., use NS 6135.

(3) For operation in low ambient temperatures from —10°F. to 50°F. use NS 3080.

l. CLEAN GUIDE VANES.

m. LUBRICATE DISTRIBUTOR BEARINGS. Follow manufacturer's instructions or paragraph 7 and table V.

n. CHECK DISTRIBUTION OF SEWAGE. If distribution is poor, inadequate coverage of filter media results. Notify manufacturer and request services of an engineer if this condition exists. Overdosing one portion of filter may cause ponding of that portion only, as it prevents intermittent penetration of air and deprives gels of the necessary oxygen supply. Since outer area of filter bed is greatest, make sure a proportionately greater quantity of sewage is discharged on that area.

D | W | M | Q | S | A

66. Dorr Reaction Units (Type KC)

For illustration of Dorr type-KC distributor, see figures 34 and 35.

28 *a.* SERVICE TURNTABLE BEARING. Flush out turntable bearing thoroughly to remove grease or grit from balls and raceway. Pour kerosene into oil fill cup, revolve machine several times, and open drain plug to let kerosene flow out. Replace drain plug and refill with oil to level marked on oil indicator. (See fig. 34.) Use NS 2190 in summer and NS 2110 in winter.

If this does not correct improper notation, dismantle center mechanism by removing turntable stops and lifting revolving assembly on jacks applied under arms as close to center as practicable. Then clean balls and races thoroughly, inspect for chipped balls and cracked races, and replace parts if necessary. If drain valve is provided, opening it and flushing the feed pipe is also desirable.

26 *b.* CHECK ELBOWS WHICH FLUSH TANK WALL. Function of small elbows in dump gate is to control development of filter-fly larvae by directing a stream at the tank wall. Clean elbows and check flushing action. If necessary, turn elbows to direct stream at different portion of wall or change their size.

27 *c.* DRAIN OFF WATER. Open oil drain to draw off accumulated water. Check oil level as shown on oil indicator and add oil if necessary.

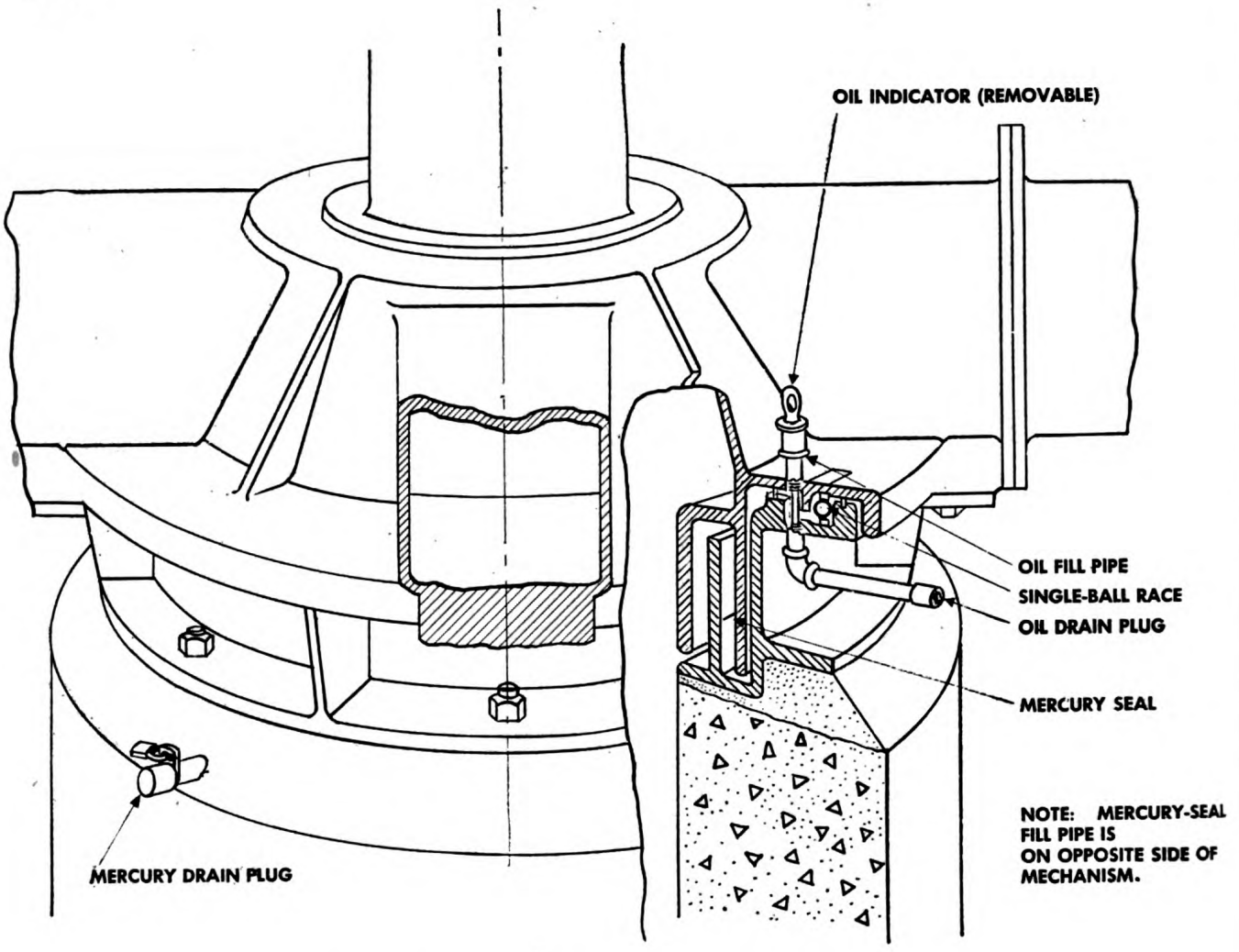
If steel particles or other foreign matter are noted in the oil, drain oil immediately, flush turntable, and add fresh oil. Repeat draining and flushing until foreign matter is removed.

29 *d.* SERVICE MERCURY SEAL. Drain mercury completely and flush out seal by hosing through opening in turntable top casting. On machines with cone-shaped center columns, a partition plate at base of column prevents access to seal well. In such cases, flush through mercury fill pipe. In any case, revolve mechanism so point of flushing is diametrically opposite drain and keep receptacle under drain to catch any mercury forced out.

(1) Clean dirty mercury, using procedure given in paragraph 65*g*.

(2) Carefully weigh mercury before replacing it in machine. If there is less mercury than was originally furnished, add mercury to replace loss. Inadequate mercury seal results in unsatisfactory operation, further loss of mercury, and damage to turntable bearing caused by sewage contaminating the oil.

30 *e.* PROTECT CONTROL PIPING AGAINST FREEZING. In cold climates, particularly if flow is small, cover dosing tank with planking during winter months to keep control piping from freezing.



OIL-FILLING ARRANGEMENT FOR DOUBLE-BALL TURNTABLE

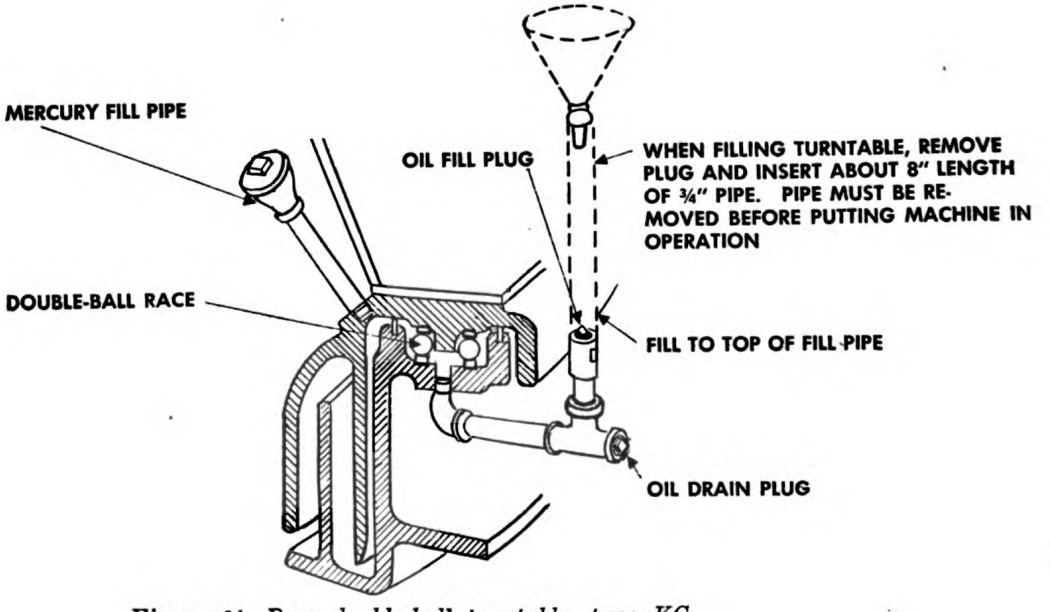


Figure 34. Dorr double-ball turntable, type KC.

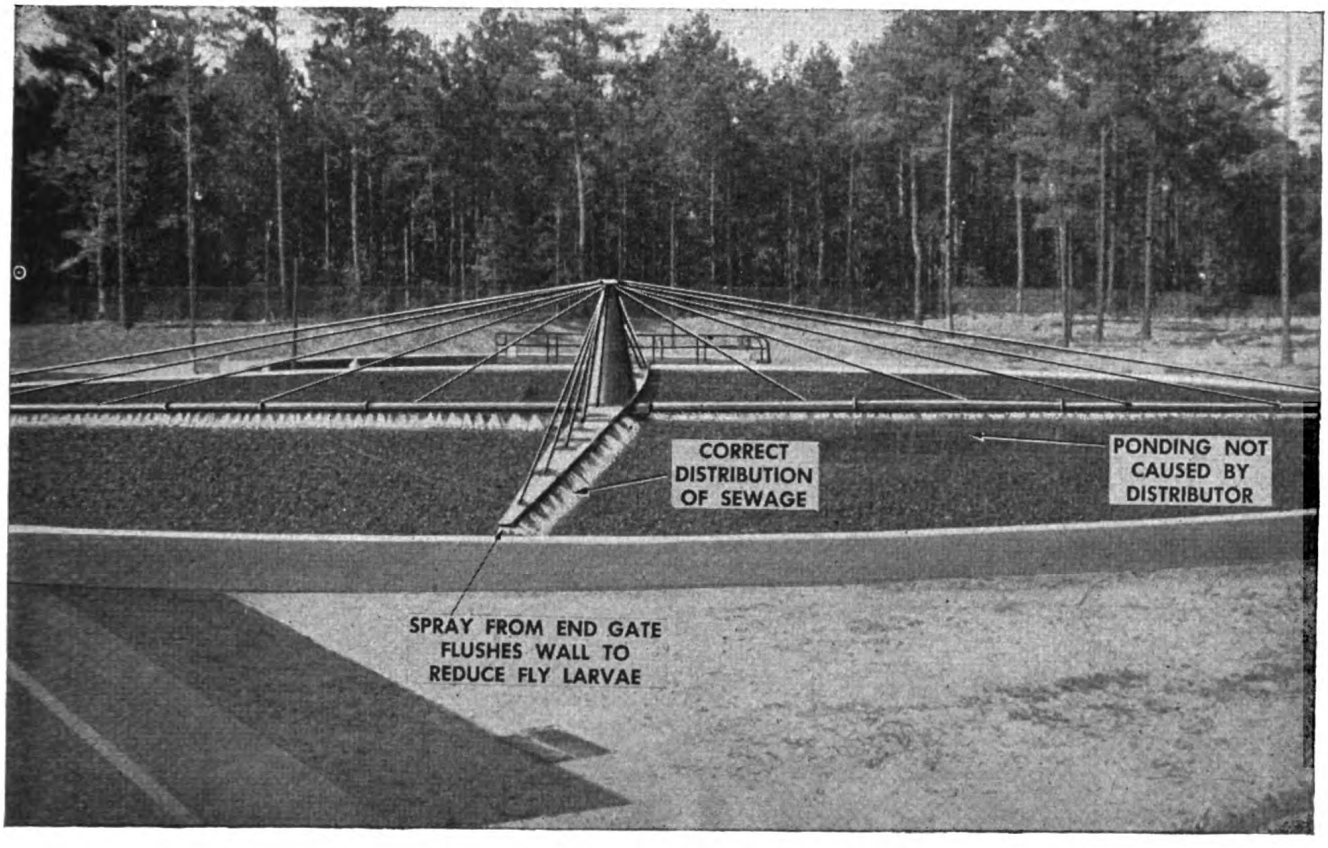


Figure 35. Dorr distributor for biofilter.

D | W | M | Q | S | A

67. Infilco Reaction Type Units

For illustration of Infilco rotary distributor, see figure 36.
Key numbers in discussion below refer to that illustration.

32 *a.* CHECK ALIGNMENT AND ADJUST ROLLERS. Check alignment of rollers (14) and adjust if necessary so rollers clear roller path by 1/64 inch when diffuser is centered. To correct alignment, remove cap (15) and loosen setscrew (12); rotate roller shaft (11), at same time forcing manifold (2) into proper position, until roller is within 1/64 inch of roller path. Tighten setscrew and locknut (13) and replace cap.

33 *b.* CHECK SEAL CLEARANCE. See that clearance between rotating manifold (2) and mercury-seal chamber (1) is approximately ⅛ inch.

34 *c.* SERVICE MERCURY SEAL. (1) *Drain off water.* Remove lower plug (10) and drain off water which may have accumulated in seal. In freezing weather, carefully heat mercury-seal casing with blow torch to melt any ice which may have formed. After draining, apply pipe compound and replace plug.

(2) *Clean mercury.* Stop flow to distributor and drain distributor through drain plug in base. Remove lower plug (10) and catch mercury in a glass, earthenware, enameled, or steel container. Never use a galvanized or tin container. Clean mercury by squeezing through chamois or clean, closely woven cloth. Remove upper plug (9) and install funnel (8) as shown in figure. Fill mercury-seal chamber with hot caustic soda solution, then flush several times with clear water.

(3) *Replace mercury.* Install funnel (8). Carefully weigh required amount of mercury and pour into funnel. Remove funnel and replace plug.

35 *d.* SERVICE MERCURY CHAMBER. Clean mercury chamber as follows:

(1) Remove the mercury. (See *c*(2) above.)

(2) Remove top cap (4), bearing (5), and removable bearing housing if present; replace cap.

(3) Remove bushing (7) and then insert lifting screw (6). Turn lifting screw until tongue of revolving manifold (2) is clear of seal chamber.

(4) Clean out accumulated debris with a stiff steel wire or a wire brush.

(5) After cleaning, lower tongue carefully into seal chamber and remove lifting screw and cap.

(6) Clean bearing with kerosene, grease thoroughly with WB 2, and replace bearing and cap.

(7) Clean and replace mercury. (See *c*(2) and (3) above.)

31 *e.* CHECK DISTRIBUTOR-ARM DRAIN HOLE. Water may freeze in distributor column, depending on sewage temperature and rate of flow. If cycles of operation are frequent enough, ice does not form inside column, and the distributor arms drain completely through drain hole in bottom of each arm. Check to make sure it remains open. If cycles are infrequent, open drain valve slightly to drain center column partially between operating cycles. If sewage is discharged from drain too fast, the siphon seal breaks and sewage flows from distributor continuously. In such case, refill siphon seal and readjust drain-valve opening.

Note. If distributor is to be taken out of service for a considerable time, drain mercury from mercury seal and store it in an earthenware jug or glass bottle.

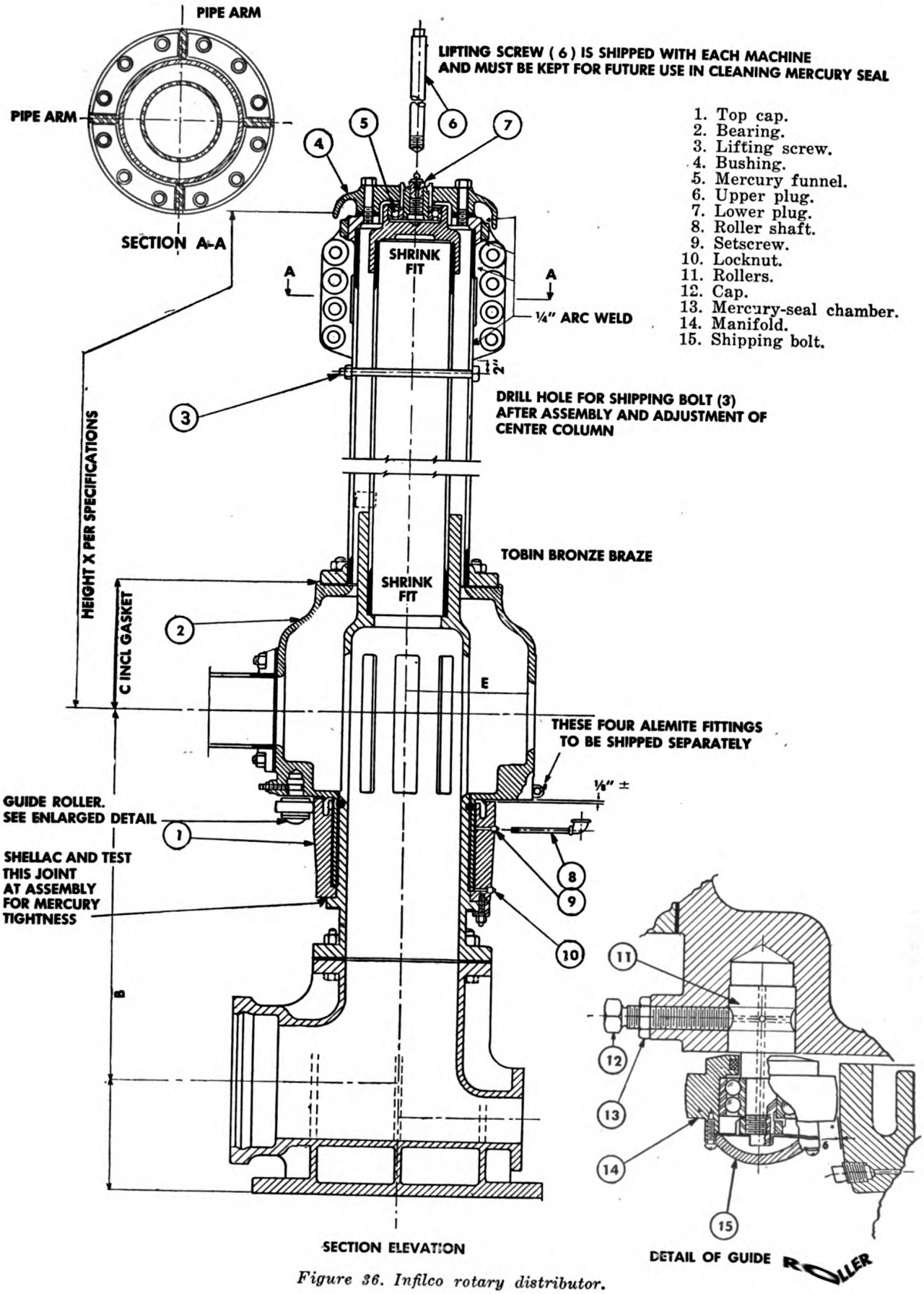


Figure 36. Infilco rotary distributor.

D | W | M | Q | S | A

68. Lakeside Engineering Reaction and Disk Type Units

For maintenance and service procedures for Lakeside Engineering reaction and disk type distributors, see paragraph 65 on chain-belt types, which have the same construction.

69. Pacific Flush Tank Reaction Type Units (30X and 40 Types)

For illustration of Pacific Flush Tank distributors, types 30X and 40, see figures 37 and 38. Key numbers in the discussion below refer to these figures.

36 *a.* GREASE TOP BEARING. Add WB 2 to top-bearing assembly through Alemite fitting (13) in top of top cap (2). To insure proper level, remove, ¼-inch pipe plug in grease drain (14) and add grease until clean grease appears.

37 *b.* CHECK OIL IN LOWER BEARING. Check oil level in lower-bearing assembly of type 30X distributor (fig. 37) by removing rain plate (10) from outer standard (5). See that oil is level with top of upper race ring (16). Add oil as necessary, using NS 2190 in summer and NS 2110 in winter.

To check oil level in lower bearing of type 40 distributor (fig. 38), loosen cap screws (9) in manifold (6), allowing rain plate to drop around base ell.

Check both types for water collecting between mercury and oil. If accumulated water reaches ball bearings, close off sewage supply and drain arms and center column through drain valve (20); then remove upper drain plug (19) and drain off water until oil appears.

38 *c.* INSPECT AND CLEAN TOP-BEARING ASSEMBLY. Inspect, clean, and replace top-bearing assembly as follows:

(1) Close inlet to dosing tank or valve in supply line so no water can enter distributor.

(2) Block distributor arms to prevent their being blown out of position.

(3) Remove bushing (1) and Alemite fitting (13) from top cap (2).

(4) Remove nuts from studs extending through top cap and allow outer standard (5) to drop down about ⅛ inch and come to rest.

(5) Insert shoulder eyebolt from tool kit through hole in top cap from which Alemite fitting and bushing were removed, and screw it into bearing support (4).

(6) Turn up eyebolt until shoulder comes in contact with top cap. Back off adjusting screws (15) which hold bearing support in place, *noting amount each screw is turned.*

(7) Remove entire bearing assembly by lifting upward, noting position of bearing support with relation to adjusting screws, so assembly can be replaced later in exactly the same position.

(8) Remove eyebolt and carefully lift off top cap.

(9) Clean bearings with kerosene and inspect for wear or breakage. Dry bearing and repack with grease, rubbing grease in thoroughly between rollers until all spaces are filled. Avoid getting sand, grit, or foreign material in grease or parts.

(10) To reassemble, loop a fine wire around lubrication seal ring (3) and slip top cap down over bearing support, removing wire from seal ring as it enters top cap.

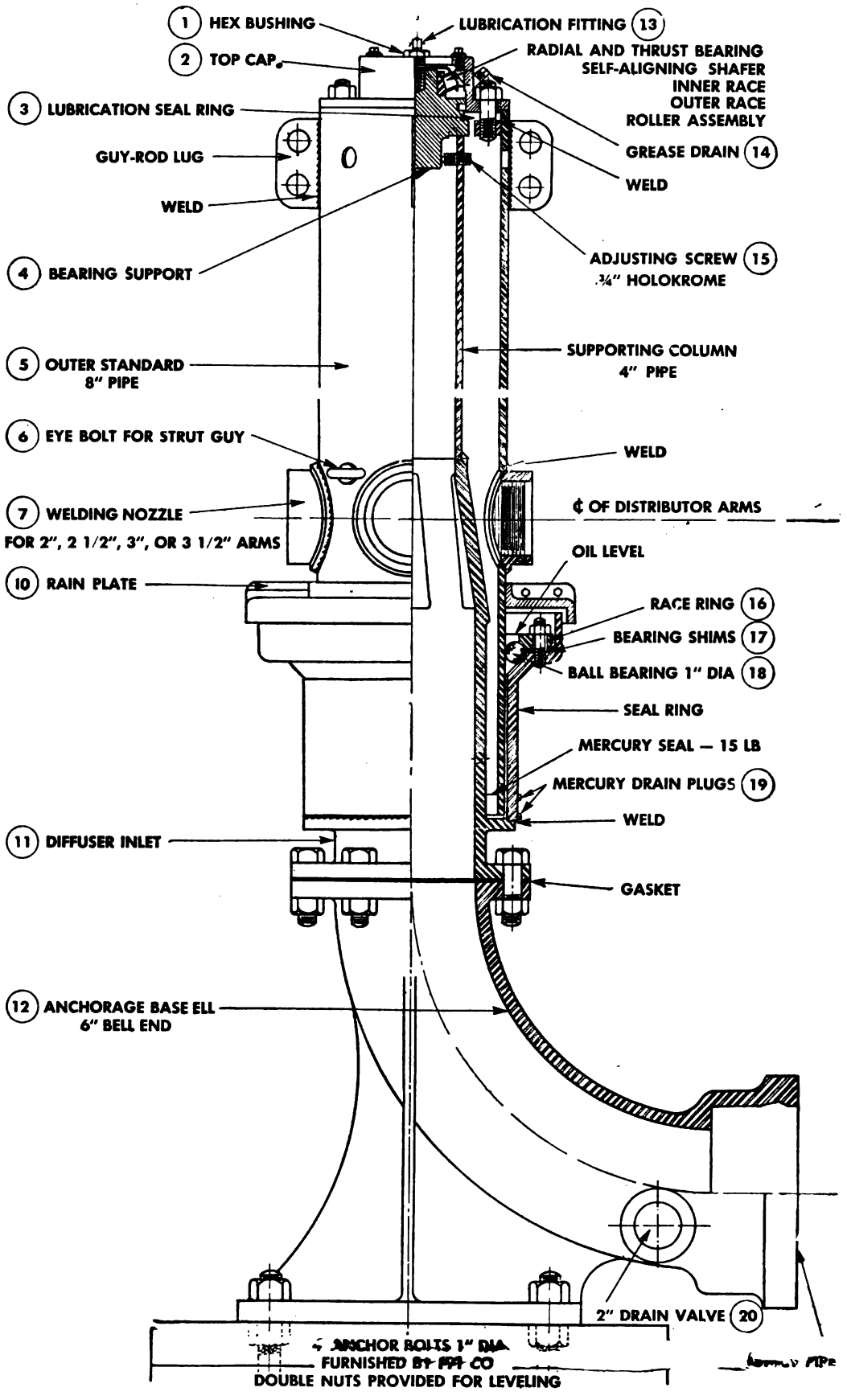


Figure 37. PFT type-30X rotary distributor.

D | W | M | Q | S | A

(11) Replace eyebolt. Replace complete bearing assembly on top of support columns, making sure bearing support is in original position. Tighten each setscrew exactly as much as it was backed off.

(12) Remove eyebolt and replace bushing and Alemite fitting. Replace cap screws and nuts through flange of top cap and pull the outer standard into position.

(13) Finish filling bearing with grease gun.

39 *d.* CLEAN LOWER BEARINGS, AND SERVICE SEAL. Drain, inspect, and oil lower bearings, following procedure below:

(1) Close inlet to dosing tank or valve in supply line so no water can enter distributor.

(2) Open drain valve (20) and drain all water from distributor arms and center column.

(3) Block distributor arms to prevent their being blown out of position.

(4) Remove rain plate (10).

(5) Place a container under drain plugs (19) to receive the oil, water, and mercury that will be discharged and then remove the upper drain plug. *Do not use a galvanized container.*

(6) Wash old oil from bearing with kerosene and replace drain plug.

(7) Remove lower drain plugs, drain out mercury, and replace plug. Check quantity of mercury in seal by weighing it, and add mercury as required to maintain full charge, 15 pounds for type 30X assembly and 17 pounds for type 40.

(8) Pour mercury back into seal through space above the lower bearing (18). Pour new NS 3080 oil on top of mercury until top bearing race is covered.

(9) Replace rain plate in position as close to outer seal ring as possible without rubbing.

40 e. ADJUST TOP BEARING TO LEVEL ARMS. If foundation for center assembly settles or if supporting column is out of line, shift upper bearing support laterally to level the arms. Make this adjustment by backing off the adjusting screws (15) to release their grip on the bearing support and to provide space for bearing support to move.

The following method is suggested for adjusting outer standard (5) so it rotates around a truly vertical axis:

(1) Follow any one arm all the way around bed's circumference, taking measurements of height of arm above top of the wall.

(2) If arm is noticeably higher through any quadrant, turn in adjusting screw on opposite side of supporting column to reduce variation in height by one half, turning out opposing screws by equal amount at same time to allow for bearing movement.

(3) When adjustments are completed for one arm, tighten adjusting screws to hold bearing support firmly in proper position.

(4) Again turn machine through complete revolution, checking one arm all the way around bed.

(5) After making this adjustment, readjust guy rods to make each arm level throughout its length.

41 *f.* CHECK EXCESSIVE PLAY IN LOWER BEARING. Although some play is necessary in lower bearing (18), if play exceeds 1/16 inch adjust as follows:

(1) Remove rain plate (10) and nuts from studs extending through race ring (16).

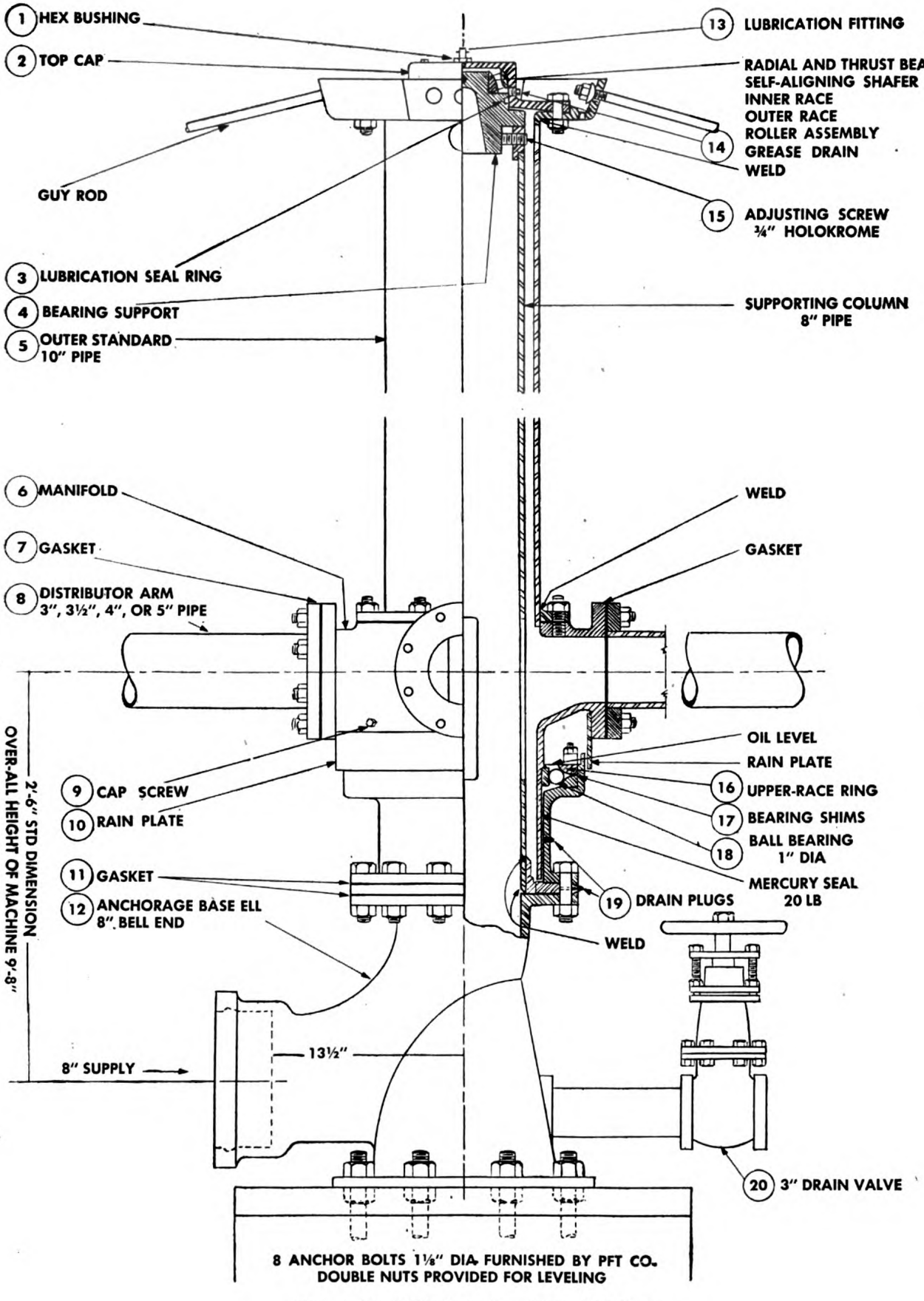


Figure 38. PFT type-40 rotary distributor.

D | W | M | Q | S | A

(2) Using two of the cap screws from rain plate, lift out race ring.

(3) Remove enough bearing shims (17) to correct the amount of play, taking same number of shims from each of the eight ½-inch studs.

(4) Replace race ring and tighten, making sure some play remains. Replace rain plate.

* *g.* PERFORM SHUT-DOWN SERVICE ON DISTRIBUTOR. Whenever distributor is to be shut down for a long time, leave drain valve (20) open.

70. Pacific Flush Tank Reaction Type Units (50 and 60 Types)

For illustrations of Pacific Flush Tank distributors, types 50 and 60, see figures 39 and 40. Key numbers in discussion below refer to those figures.

43 *a.* SERVICE MERCURY SEAL. Check mercury in seal as follows:

(1) Close inlet to dosing tank or valve in supply pipe so no water can enter distributor.

(2) Open drain valve (20) to drain water from distributor arms and center-column assembly.

(3) Remove upper drain plug (19) and collect all liquid in a container (not galvanized). Replace drain plug.

(4) Remove lower drain plug (19), catch mercury and replace plug.

(5) Separate out impurities and weigh mercury, adding mercury required to maintain full charge, 30 pounds for type 50 and 40 pounds for type 60.

(6) Return mercury to seal by removing plug in mercury-recovery trap (18) and pouring mercury into seal. Replace plug.

36 *b.* GREASE TOP BEARINGS. See paragraph 69*a*.

42 *c.* LUBRICATE LOWER ROLLERS. Lubricate lower rollers (9) through Alemite fitting (10). Use BR grease.

38 *d.* INSPECT AND CLEAN TOP-BEARING ASSEMBLY. See paragraph 69*c*.

44 *e.* INSPECT AND ADJUST LOWER ROLLERS. Follow procedure given below:

(1) Close inlet to dosing tank or valve in supply pipe so no sewage can enter distributor.

(2) Block arms so they cannot settle or be blown out of position.

(3) Remove roller cap (17) and, with special wrench furnished with machine, take out roller shaft (16).

(*a*) Shaft for type-50 assembly is held in place with setscrews (7) which must be loosened before shaft is removed.

(*b*) Shaft for type-60 assembly is held in place by a nut and lock washer above flange of inner seal ring (8).

(4) Mark rollers to insure replacing them in their correct position.

(5) Clean bearing with kerosene and inspect for wear or breakage. Dry bearing and pack grease into all spaces by hand, taking care to prevent entry of grit.

(6) Replace roller cap and finish filling with grease gun until excess is forced out opposite side of bearing.

(7) Replace bearing assembly on machine and tighten setscrew or nut holding bearing shaft in position.

40 *f.* ADJUST TOP BEARING TO LEVEL ARMS. See paragraph 69*e*.

* *g.* PERFORM SHUT-DOWN SERVICE ON DISTRIBUTOR. See paragraph 69*g*.

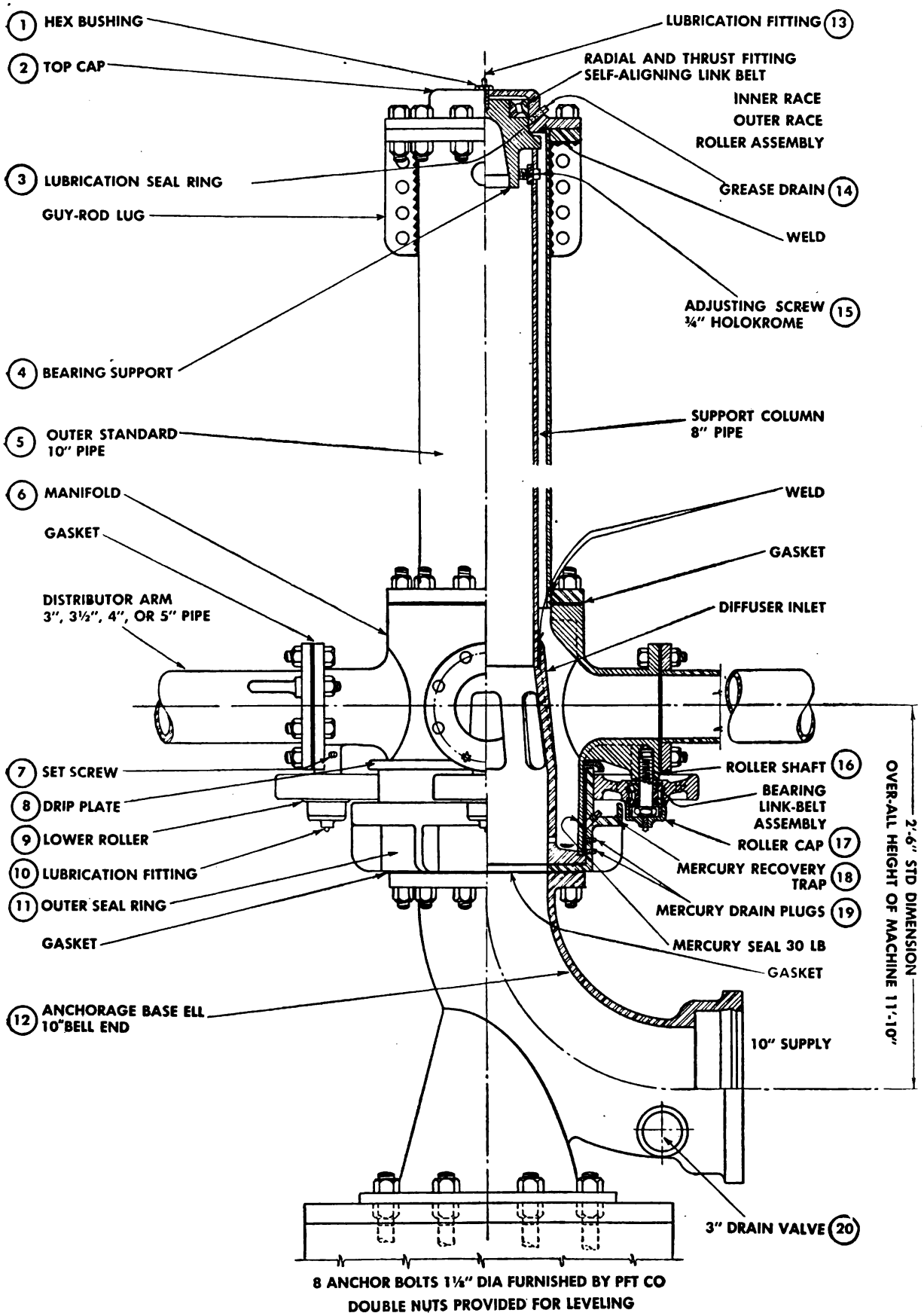


Figure 39. PFT type-50 rotary distributor.

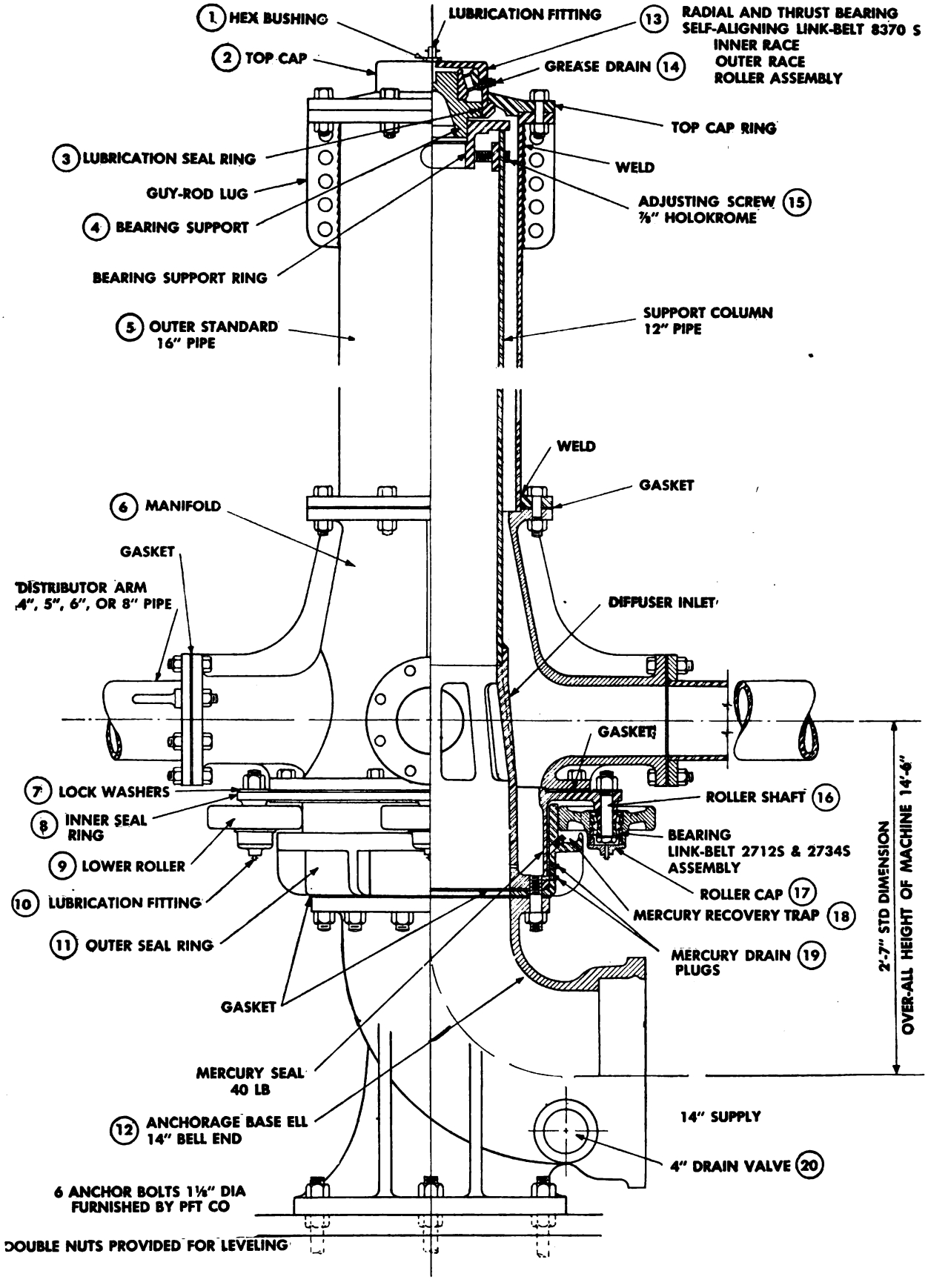


Figure 40. PF'T type-60 rotary distributor.

D	W	M	Q	S	A
		45			
					46
		42			44
					43

71. Yeoman's Reaction Type Units (fig. 41)

a. LUBRICATE TOP BALL BEARING. Grease top ball bearing in distributor column sparingly with BR grease. Clean face of rollers and roller path on distributor column; add thin film of grease after cleaning. Consider local conditions to determine proper interval for this cleaning.

b. LUBRICATE DOUBLE BEARING AND ROLLER PADS. Lubricate double bearing in top of center column through Alemite hydraulic fitting. Avoid excessive greasing which forces grease past seal on inside of column. Lubricate roller pads with a thin film of grease on surface. Clean roller face and its path of travel and apply new BR grease.

c. LUBRICATE, CLEAN, AND ADJUST GUIDE ROLLERS. See paragraph 70*c* and *e* for general method.

d. SERVICE MERCURY SEAL. See paragraph 70*a* for general method.

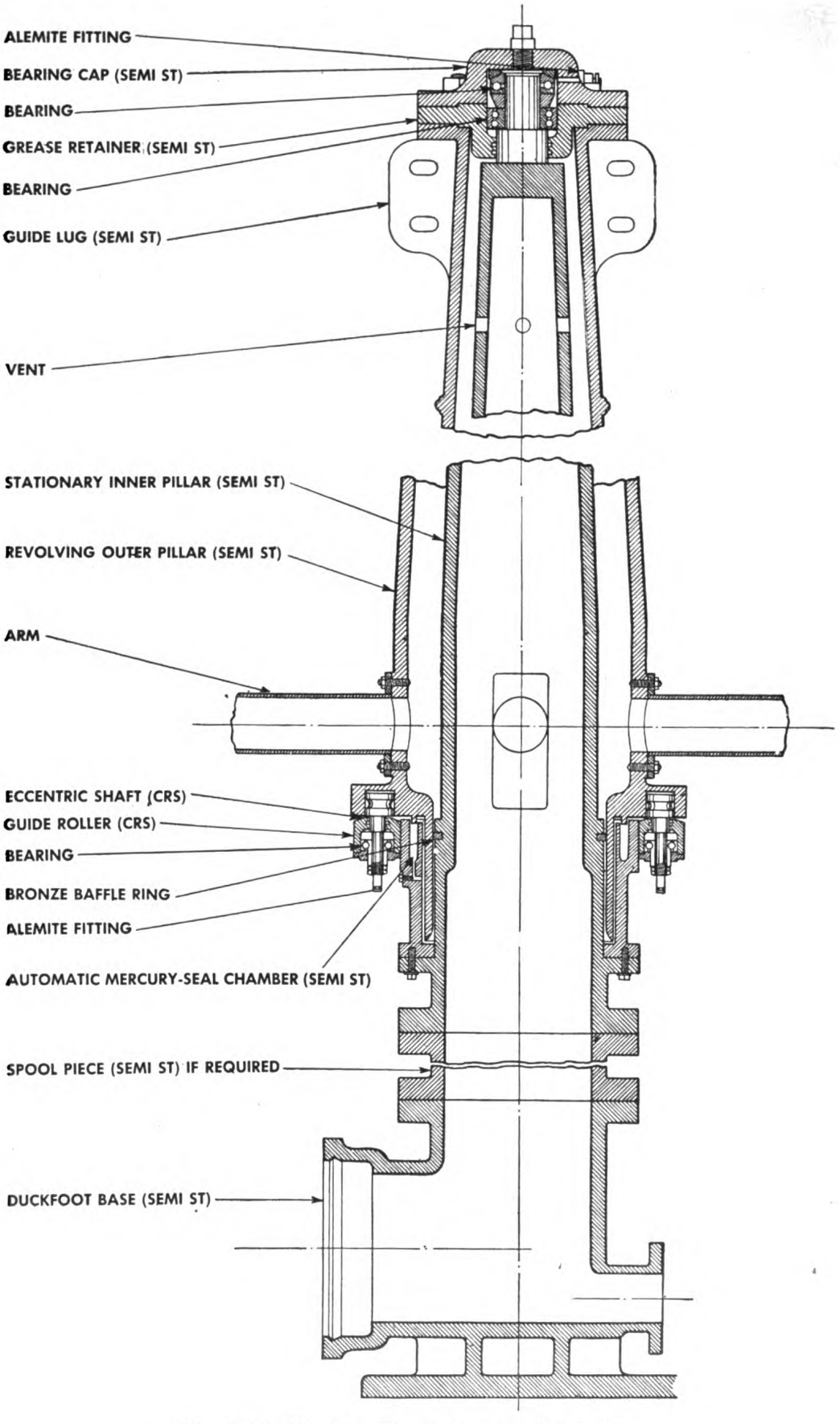


Figure 41. Yeoman's-Simplex rotary distributor.

SECTION XIII

DOSING SIPHONS

72. Infilco Type Siphons

2 *a.* TEST DOSING SIPHON. (1) Install ½-inch street ell and a test pipe vertically in tapped opening at entrance to one arm of rotary distributor.

(2) Remove pipe plug and turn disk down with screw driver until it stops at end of discharge pipe. Back off disk six turns and replace pipe plug. Admit just enough water or sewage to dosing tank so water dribbles out of rotary distributor nozzles; then fill leg of siphon blowoff trap with water.

(3) Again admit water or sewage to dosing tank until siphon blows and observe elevation of liquid in test pipe. If level is below top of pipe, remove plug and back off disk one turn.

(4) Replace pipe plug and repeat test, continuing disk adjustment until liquid rises approximately to top of test pipe. Disregard water which discharges from pipe along with air.

Caution: Do not carry liquid level above top of pipe; that would indicate a water head great enough to force mercury out of seal.

1 *b.* CHECK PIPE-PLUG SEATING. Make sure pipe plug seats tightly because any air leak makes siphon inoperative.

3 c. CHECK MERCURY SEAL ON CONNECTED DISTRIBUTOR. For procedure, see paragraph 67*c*.

73. Pacific Flush Tank Type Siphons (fig. 42)

4 *a.* CHECK AIR PIPING FOR OBSTRUCTIONS. Keep air piping open and free from obstructions. If piping is designed with a ½-inch hole in side of blowoff trap 6 to 12 inches above return bend, clean hole with a bent wire.

* *b.* PERFORM SHUT-DOWN SERVICE. When it is necessary to close down a distributor for any length of time, use following procedure:

(1) Close inlet to dosing tank.

(2) Open valve in base ell of distributor or drain valve in fixed-nozzle field piping and drain dosing tank and connecting pipe from siphon to distributor.

(3) Drain vent pipe on side of siphon bell by unscrewing it one-half turn, leaving it upside down.

(4) Drain or remove blowoff trap at connection with siphon bell.

(5) If drain is provided for dosing tank, open it.

Abbreviations: D, means daily; W, weekly; M, monthly; Q, quarterly; S, semiannually; A, annually.

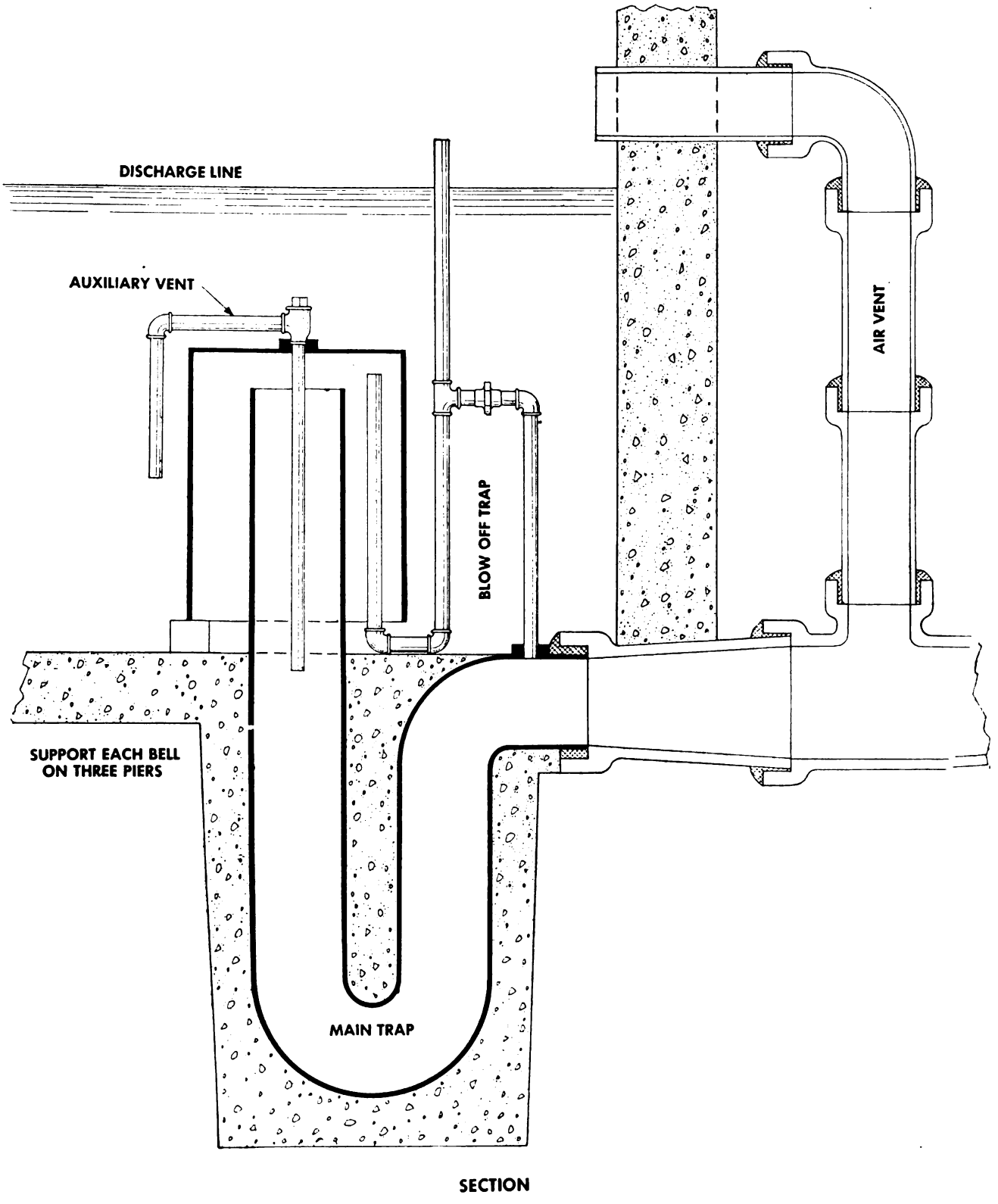


Figure 42. Dosing siphon.

SECTION XIV

AERATION TANKS AND APPURTENANCES

D	W	M	Q	S	A

74. American Well Works Mechanical-Aeration Type Units (figs. 43 and 44)

1 *a.* GREASE LOWER SLEEVE BEARING. With a Zerk gun, apply four shots of WB 2 grease through proper fitting in motor floor plate.

5 *b.* GREASE UPPER BALL THRUST BEARING. With a Zerk gun, apply four shots of BR grease through proper fitting in motor floor plate.

2 *c.* SERVICE AIR-TUBE TYPE AERATION UNITS. During manual operation, air valve remains wide open. Shut valve completely for 15 minutes and run unit without injection of air. This increases circulation in unit temporarily, sweeping entire tank floor clean.

3 *d.* CHECK AIR INPUT. If air input tends to fall off on grease-flotation units, introduce a small amount of lye solution through air tube to dissolve any grease accumulated at air ring.

6 *e.* ADJUST WATER LEVEL IN WELL TYPE TANKS. Adjust differential between water level in well and water level in tank to provide maximum entrainment of air as observed by bubbles at the tank surface. Maintain a drop of 10 to 12 inches from tank-operating water level to inner-well water level to get best results from air-diffusion and grease-flotation units. Adjust water level by adjusting weirs on side of well or orifice covers on injection plate. Brush off injection plate and reverse machine to minimize fluctuation of drop in water levels.

† *f.* CHECK MOTOR CONDITION. See paragraph 14.

4 *g.* REVERSE SWITCH. If unit is equipped with reversing switches, reverse it for several minutes. *Let shaft come to complete standstill* before reversing unit, and take same precaution when starting unit.

75. Chicago Swing-Diffuser Type Units

7 *a.* LUBRICATE BEARING AND SEAL RINGS. Lubrication is the only maintenance swing-diffuser mechanism requires. Each swing and knee joint has two greasing points, one for the bearing and one for the seal rings. Give each point two or three shots of WB 2 grease, preferably during summer months. To lubricate swing-joint shaft bearing, replace plug in end of shaft with a No. 1600, ⅛-inch Zerk Alemite fitting and apply grease. Remove fitting, and put plug back so hoist clamp will not damage fitting during raising or lowering operation. Because hoist is not waterproof, keep it under shelter to protect it against wetting.

8 *b.* GREASE FAFNIR BALL BEARINGS. Grease the two ball bearings on chain-jack shaft of hoist by removing plugs on bearing housings and adding five shots of CG 1 grease with a grease gun.

9 *c.* OIL CLAMP-WHEEL SCREW AND SLEEVE BUSHINGS. Clamp-wheel screw on hoist is exposed at one oil opening on top. When screw is dry, wet it with

Abbreviations: D, means daily; W, weekly; M, monthly; Q, quarterly; S, semiannually; A, annually.

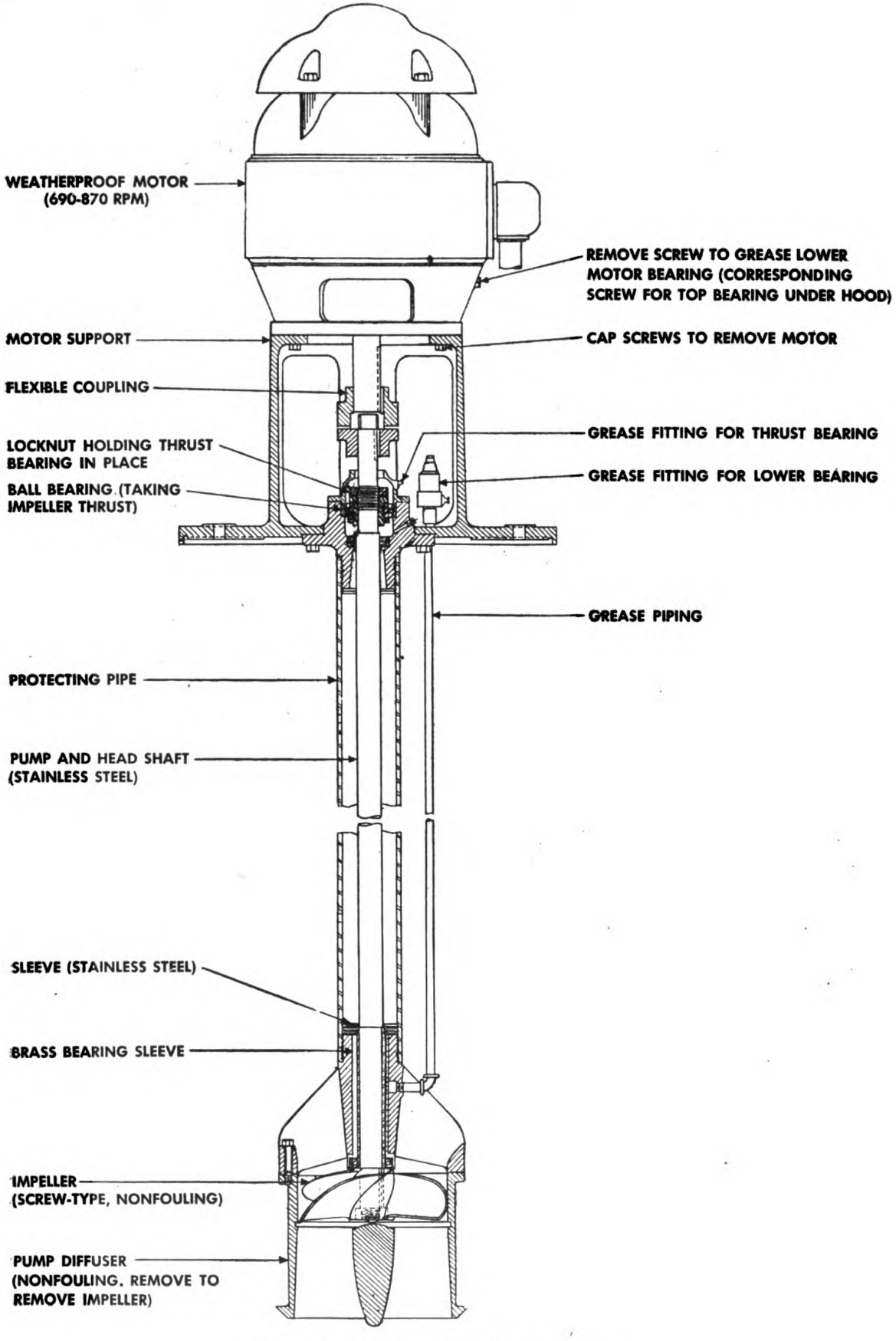


Figure 43. American Well Works aerator.

D	W	M	Q	S	A
					10
11					
			18		

a little OE 10. Keep film of oil on sleeve bushings at grooved coupling (clamp cup); add oil around edges of thrust plate (outside plate).

d. LUBRICATE MOTOR AND CRANE CHAINS. Keep motor and crane chains covered with a thin film of rust-preventive compound CT.

76. Connersville Positive-Displacement Blowers (fig. 45)

a. GENERAL. Follow maintenance procedure below to insure proper operation of positive-displacement blowers used in activated sludge and contact-aeration processes.

(1) *Check lubrication.* After unit is first placed in service, check oil level twice daily for first week and daily thereafter.

(2) *Check quality of oil.* Change oil quarterly if unit operates continuously; increase frequency if unit operates in very dusty atmosphere. Since there is no contact between rotating impellers or between impellers and case, wear is confined to bearings and gears. Use following oils to lubricate bearings and gears on all types of Roots-Connersville blowers and gas pumps operating under normal temperature conditions. Up to 25 bhp, use OE 30; over 25 bhp, use NS 3080. Where unusual temperature conditions prevail, write factory for recommendations. See manufacturer's drawings for bearing lubrication points. Pack bearings with BR grease.

Caution: Use care in packing bearings, as packing under considerable pressure causes overheating.

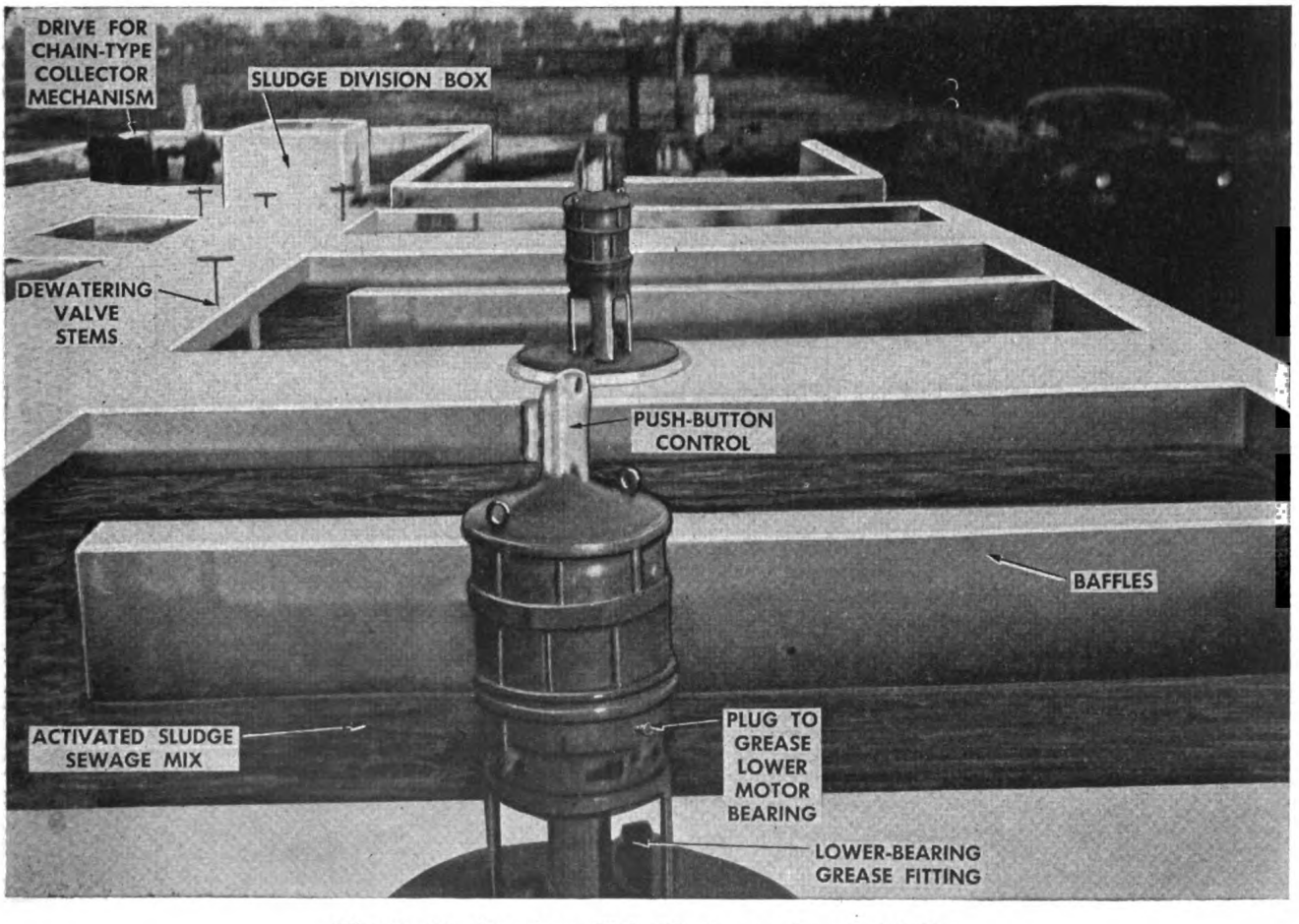


Figure 44. American Well Works aerator installation.

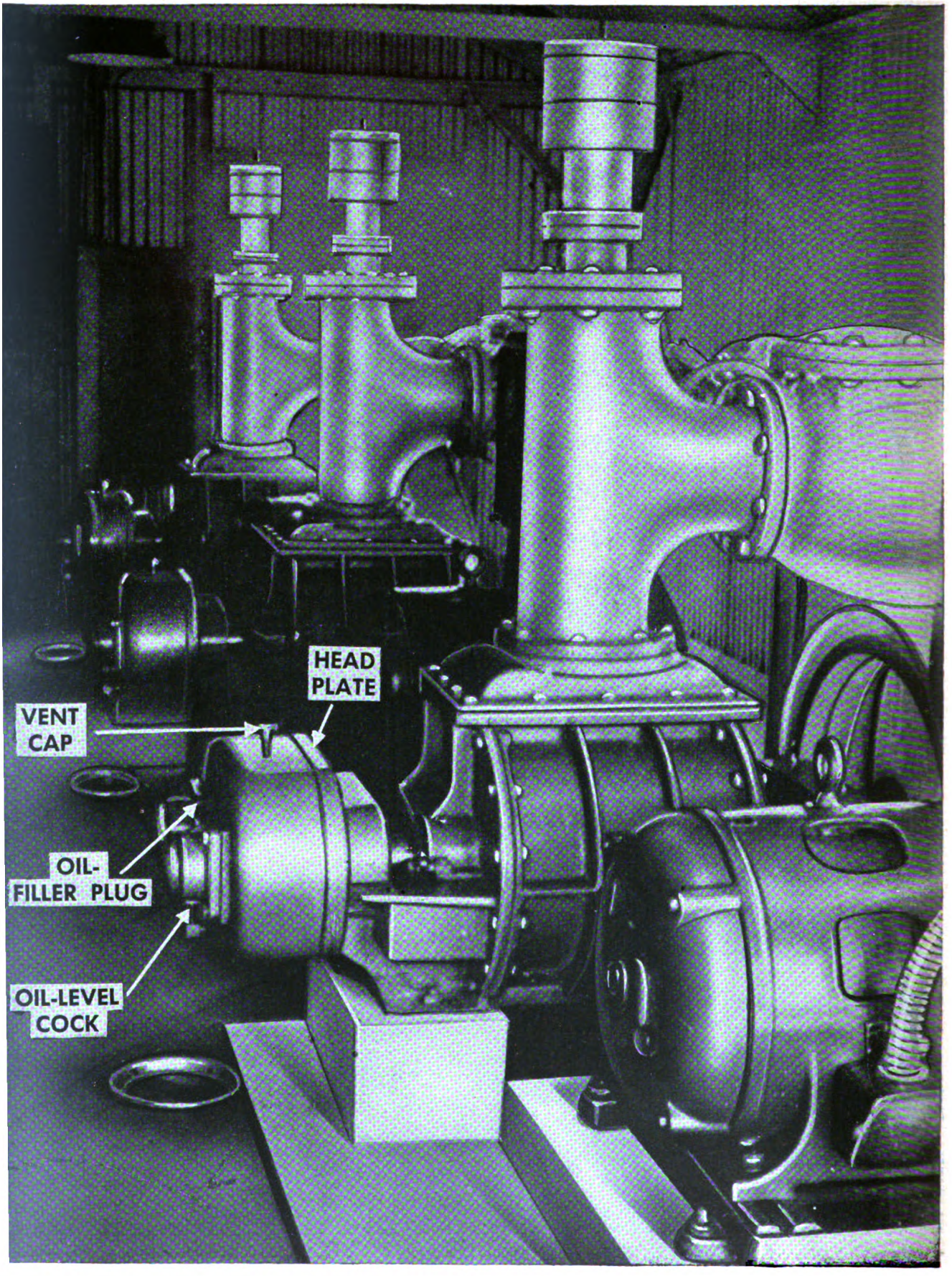
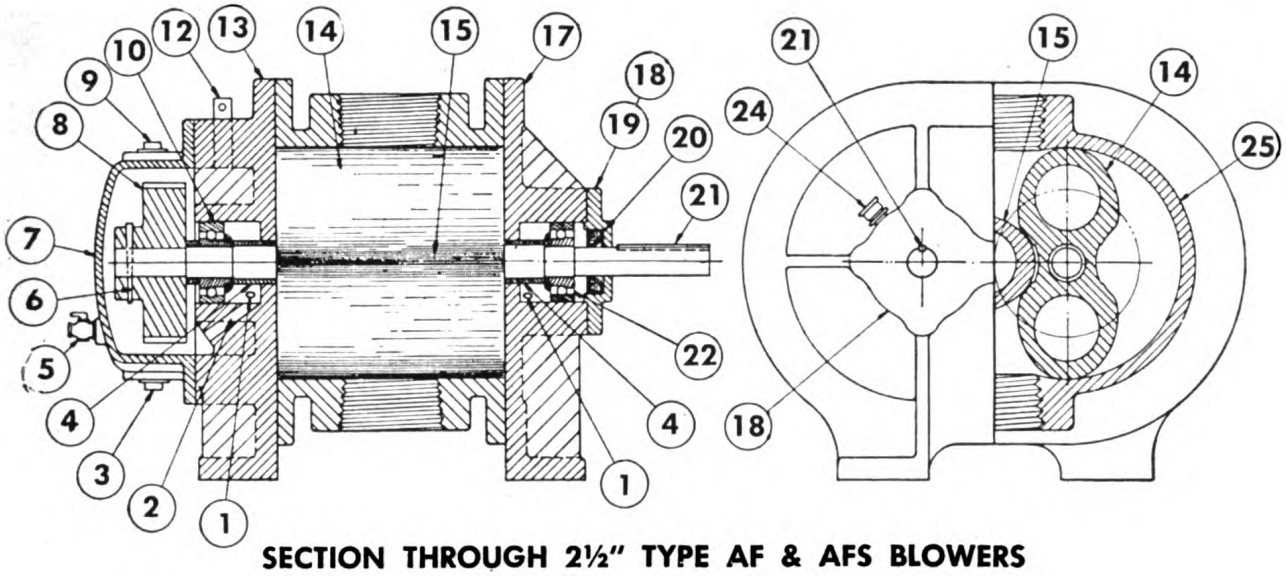
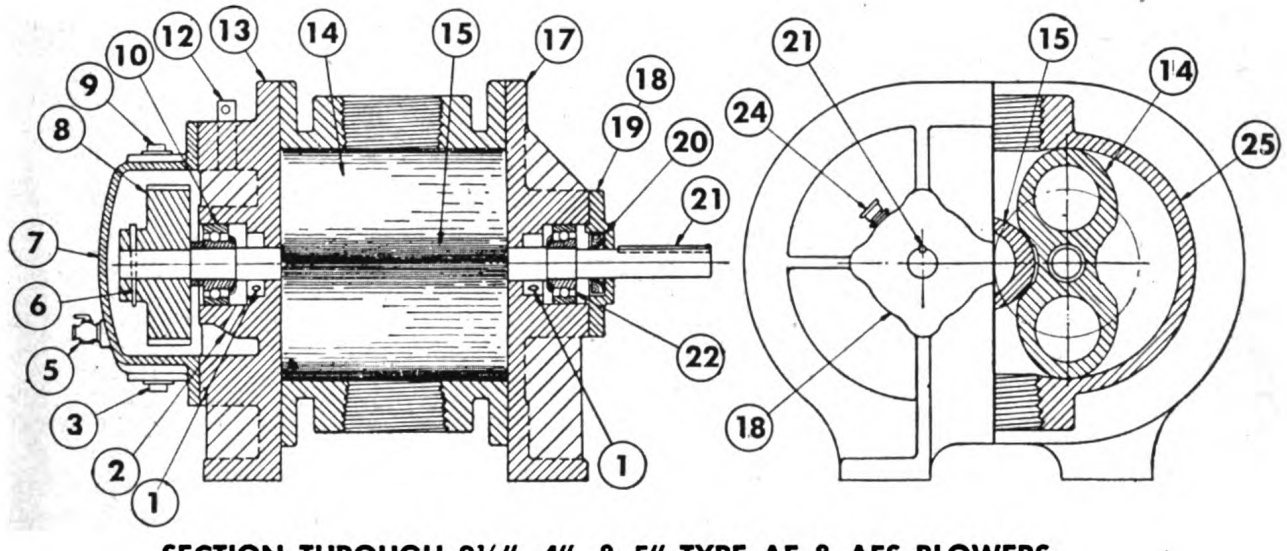


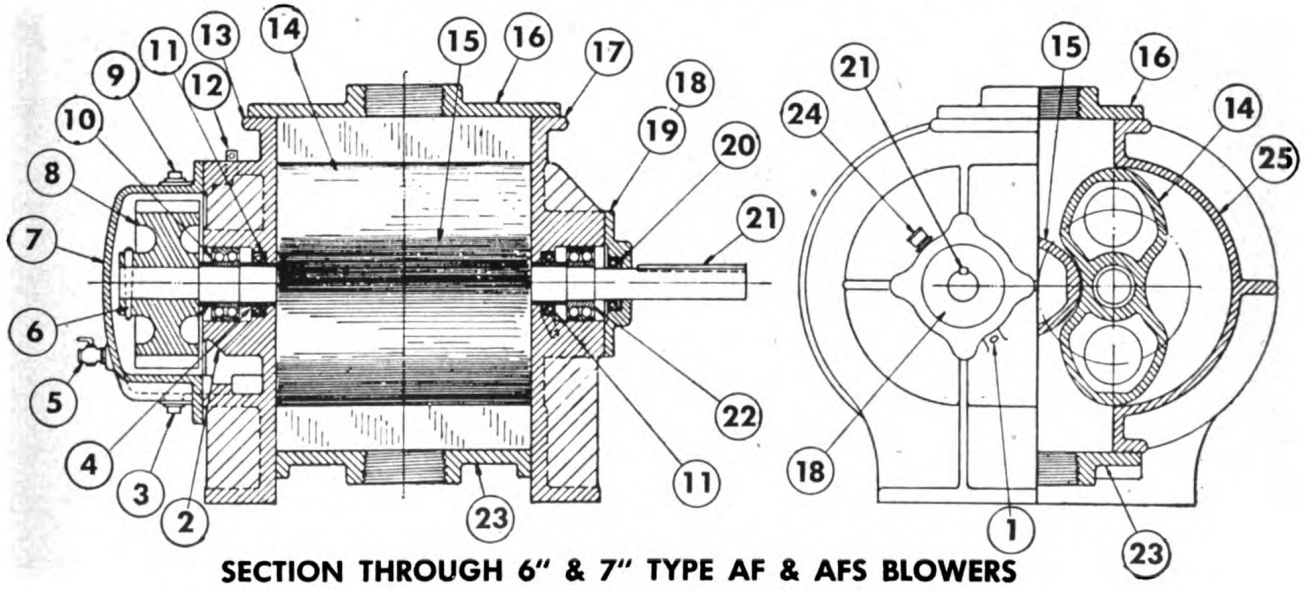
Figure 45. Blowers.



SECTION THROUGH 2½" TYPE AF & AFS BLOWERS



SECTION THROUGH 3½", 4", & 5" TYPE AF & AFS BLOWERS



SECTION THROUGH 6" & 7" TYPE AF & AFS BLOWERS

Figure 45. Blowers—Continued. (See page 116 for key.)

b. GREASE IMPELLER HUB. Apply GG graphited grease through pressure connections to lubricate ends of impellers when unit is first started. Use only a small amount of grease at these points.

c. LUBRICATE FLEXIBLE COUPLINGS. Check gear type and spring type flexible couplings for adequate lubrication. Add GO 90 as needed.

d. CHECK ALIGNMENT OF FLEXIBLE COUPLINGS. Although flexible couplings can handle slight misalignment, accurate alignment improves operation. For methods of aligning, see paragraph 19.

e. CHECK CONTROL-VALVE OPENING. Use a bypass or bleeder valve to control volume of air delivered by constant-speed, motor-driven, positive-displacement blower. Keep control valves open fully. Do not restrict or throttle inlet or discharge of positive-displacement blower as this causes excessive pressure and waste of power.

f. CHECK INLET AND DISCHARGE PIPING. Make sure piping is well supported to prevent blower-case distortion.

g. CHECK EXPANSION JOINTS AND FLEXIBLE-PIPE CONNECTORS. Make sure they are tight and not slowly slipping longitudinally.

h. DETERMINE PRESSURE. Measure discharge pressure with a manometer and observe any pressure increase that discloses clogging of connected piping, orifices, or diffusers.

i. CHECK RPM. Check speed of blower with a speed counter to determine belt slip or change in blower capacity due to causes other than wear.

j. CHECK MOTOR CONDITION. See paragraph 14.

k. PERFORM SHUT-DOWN SERVICE. When unit is to be out of service for long periods, coat impellers and inside of cylinders with OE 50 or PE 30 to prevent rusting, corrosion, and sticking. Before resuming operation, replenish lubricating oil in bearings and gears and rotate unit by hand to see that it turns freely.

77. Diffuser Plates and Tubes

a. INSPECT PLATES AND TUBES FOR FOREIGN MATTER. Prevent troublesome clogging of air diffusers by proper preventive maintenance.

(1) *Causes of clogging.* (*a*) Common causes of diffuser-plate and tube clogging are organic growths, grease accumulations, dirt and soot deposited on plate bottoms by applied air, sand and silt impregnations at the surface, and hard-water scale. Clogging can be reduced by eliminating these causes.

(*b*) Clogging also results when power failure or mechanical break-down interrupts the air supply, allowing solids to sink to the bottom. To prevent that type of clogging when aeration unit is to be removed from service, continue applying air until tank is completely drained.

(*c*) Grease and silt deposits increase rapidly when diffusers become partially clogged. Schedule regular cleaning of diffusers to reduce this accelerated clogging and increase life of plates.

1. Vent.
2. Oil drain.
3. Oil-drain plug.
4. Shaft sleeves.
5. Oil-level cock.
6. Taper pins.
7. Gear house.
8. Timing gears.
9. Oil-filler plug.
10. Bearings (gear end).
11. Oil retainer (head plate).
12. Vent cap.
13. Head plate (gear end).
14. Driven shaft and impeller.
15. Driving shaft and impeller.
16. Top pipe plate.
17. Head plate (driven end).
18. End cover (drive).
19. End cover (blind).
20. Oil retainer (end cover).
21. Pulley key.
22. Bearings (drive end).
23. Bottom pipe plate.
24. Bearing lubrication cup.
25. Cylinder.

Figure 45. Blowers—Continued.

D | W | M | Q | S | A

(2) *Methods of cleaning.* Normal intervals for cleaning plates and tubes may vary from semiannually to once every 2 years, depending on severity of clogging. Record air pressure monthly to determine need for cleaning. When replacing diffuser plates, change all plates in the same row or holder to avoid unequal air distribution. In cleaning plates and tubes, use the correct procedure for the type deposit encountered.

(*a*) *General.* Wash plates or tubes with high-pressure water stream, brush vigorously, and rewash.

(*b*) *Organic deposits.* When organic deposits are involved, wash plates or tubes with hose. Sweep with stiff brush and allow to dry. Apply a 25 percent caustic soda solution to plates or tubes and leave it on for 24 hours.

(*c*) *Grease.* Remove grease accumulation by forcing low-pressure steam through plates or tubes while brushing vigorously with a stiff brush.

(*d*) *Scale.* To remove scale, use a stiff brush followed by application of a weak muriatic acid solution. When ferrous iron deposits are the source of trouble, use a solution of equal parts water and sulfuric acid to which sodium dichromate is added.

(*e*) *Crusted surfaces.* Apply hot flame to spall off plate surface, using blow torch on silica plates and oxyacetylene flame on carborundum plates.

Caution: Wear suitable protective clothing when using caustic, acid, or torch to clean or spall diffusers.

78. Contact-Aeration Units

22

a. CLEAN SUBMERGED AIR GRID. In contact-aeration plants, erect vertical riser pipes at each end of pipe grid to a point above liquid surface. Insert valve at end of pipe.

(1) Open valve, creating aspirator effect; when air rushes through pipe grid, it carries some moisture from orifice openings. (See fig. 46.) Combination of air and liquid scours upstream face of orifices on inside diameter of pipes in grid.

(2) Close valve quickly to bump aeration tank with sudden rush of air through pipe orifices. This blows off accumulated organic matter lodged over orifice on outer edge of pipe grid, thus eliminating some clogging without draining tank.

23

b. CHECK AIR PRESSURE. Check air pressure at blowers and speed of blower. If speed is normal and pressure is appreciably increased, clean orifices in submerged grid. Try cleaning them first with a portable compressor or water, by connecting an air or water hose to blowoff valve. *Do not let water get into blower.* If orifices cannot be opened by air or water, drain tank and clean them. Whenever tank is cleaned, examine orifices and check orifice spacing, since some pipe grids do not have enough orifices. If orifices are spaced more than 2 inches apart, drill ⅛-inch diameter orifices between existing ones.

24

c. CHECK PLATE SPACERS OR SPREADERS. Inspect spacers or spreaders for security of anchorage. Insert extra ones where cement-asbestos plates become too bowed.

25

d. CHECK PLATES. Check plates to see that bearing of upper plate is secure to lower plate. Drain tank contents so level is below top of plates.

26

e. CHECK ANCHORAGE OF PLATES. Every 2 years, drain tank to inspect supports for cement-asbestos plates. Check for corrosion and repairs when necessary. Clean and paint metallic supports.

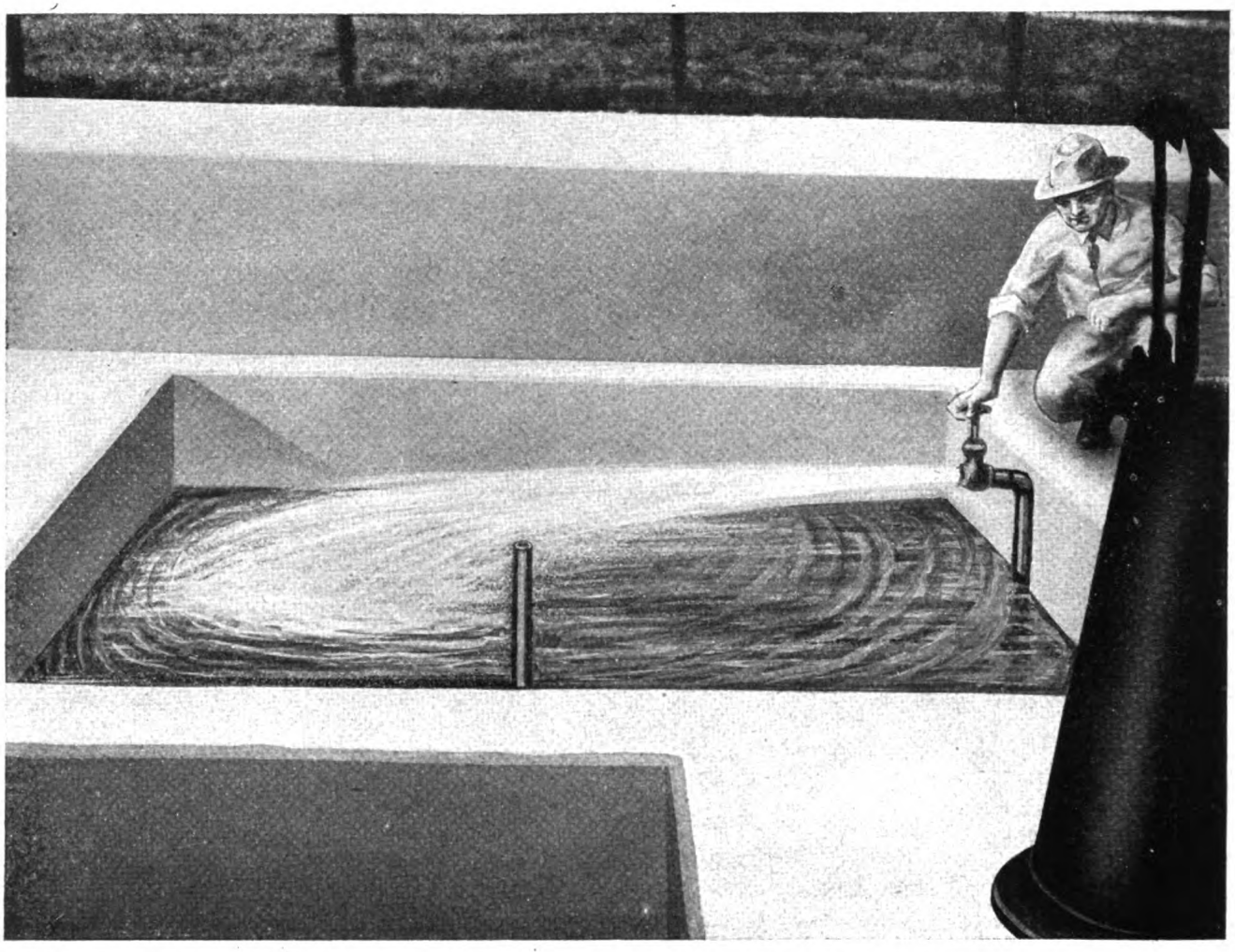


Figure 46. Using blowoff or aspirator for cleaning submerged grids.

SECTION XV

INTERMITTENT SAND FILTERS

D	W	M	Q	S	A	
						79. General
		1				*a.* CLEAN BEDS. Scrape beds clean as often as necessary to maintain filter capacity. Use shovel or hand or scoop type scraper. Remove scrapings from bed. If *absolutely necessary*, rake or harrow lightly after beds have been scraped.
					4	*b.* REPLACE SAND. Add new sand to restore original bed elevation.
				3		*c.* RIDGE BEDS. In northern climates only, ridge beds before heavy freezing weather. Make ridges 3 feet on centers and 10 inches deep. Scrape beds before ridging and before restoring to normal elevation. For further information, see TM 5–665.
			2			*d.* INSPECT UNDERDRAINS. Inspect underdrains for clogging by sand or growths. Flush or clean as required to maintain free flow.
						80. Dunbar Filters
					*	*a.* CLEAN BEDS. Clean beds with broom after each period of application of sewage. Remove dirty material from beds. Use flagstones to eliminate sand erosion caused by concentrated discharge at points of dosage.
					6	*b.* REPLACE FINE GRAVEL. Add new fine gravel of proper size to restore original bed elevation.
			5			*c.* INSPECT UNDERDRAINS FOR CLOGGING. Flush or clean underdrains as required to maintain free flow.

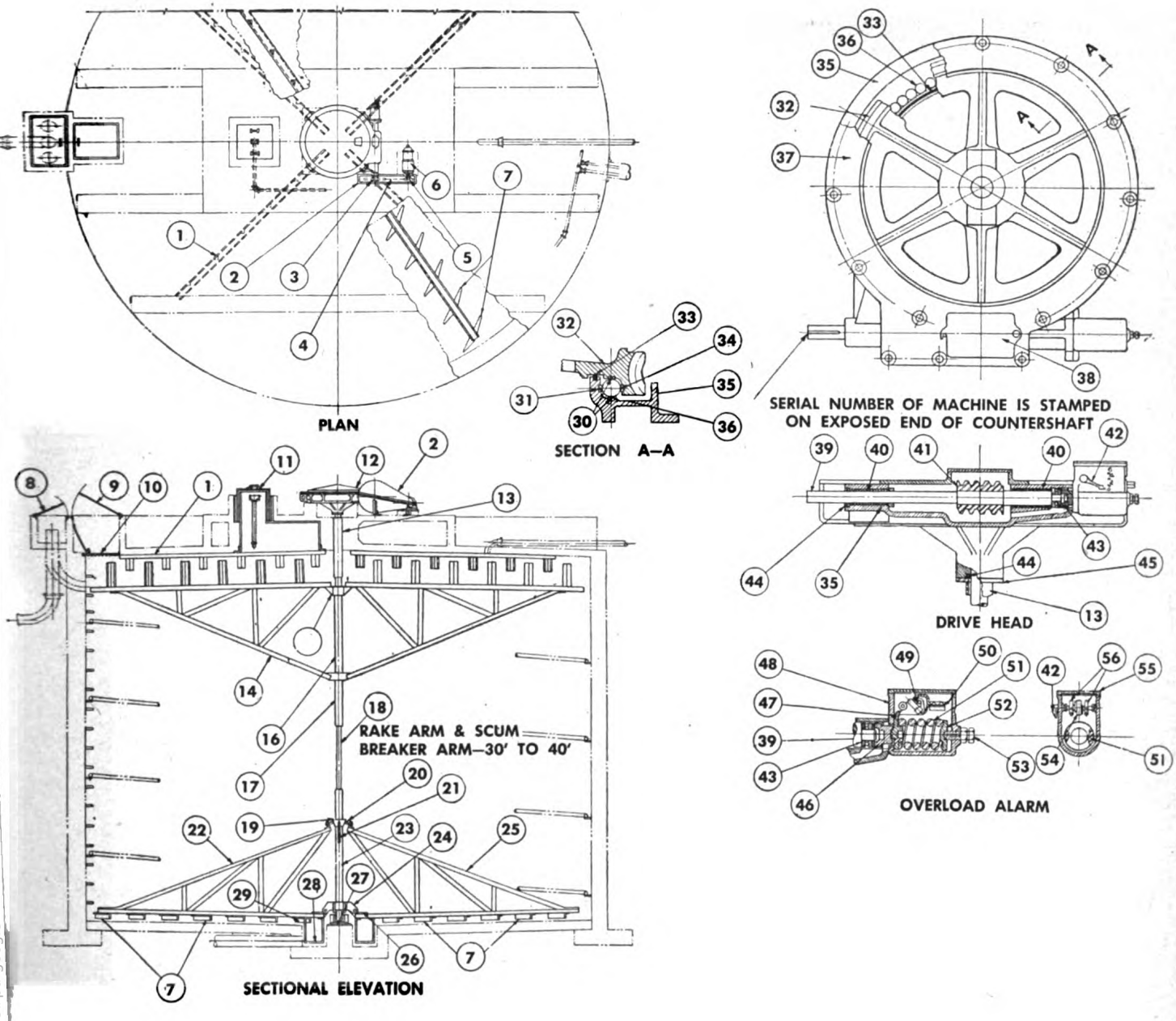
Abbreviations: D, means daily; W, weekly; M, monthly; Q, quarterly; S, semiannually; A, annually.

SECTION XVI

DIGESTION-TANK EQUIPMENT AND APPURTENANCES

D	W	M	Q	S	A	
						81. Dorr Digester, Fixed-Cover and Clarigester Type Units (figs. 47, 48, and 49)
				9		*a.* INSPECT UNIT TO PREVENT OVERLOAD. Check operation of overload pointer; it should move to left to indicate overload. Make sure sludge lines are not clogged, and flow from clarifier is not carrying too much grit or sludge.
						(1) If overload results from clogged sludge lines, connect high-pressure water to discharge line and force water through that line. This clears most stoppages in sludge lines.
						(2) If excess grit or sludge from clarifier causes overload, operate sludge pump connected to digester underflow until accumulated grit or sludge is removed.
						(3) Overload may also result if foreign objects are dropped into the tank. If they are not eliminated by pumping for a short time, stop mechanism, back up vertical shaft one-eighth turn, and resume operation. If this fails, shut down mechanism and remove foreign object, emptying tank completely if necessary.
						Caution: If large foreign objects such as rocks or tools are dropped into digester, stop operation immediately and do not resume operation until objects are removed.
					*	*b.* SPRAY GAS DOME. Water sprays may be provided in gas dome of gas-collection type digesters, for use when scum tends to fill dome and plug gas line. When too much scum forms, remove screens and operate water sprays to keep foam down and clear the gas line. Remove scum through scum drain from gas dome as required.
		5				*c.* CHECK ADJUSTMENTS AND ALIGNMENTS. Inspect and tighten all bolts. Maintain original adjustments and alignments.
	1					*d.* CHECK MECHANICAL PARTS. (1) Test overload-alarm bell and automatic-cutout switch for proper working condition. Raise overload pointer to see whether bell and switch operate.
						(2) Inspect all gears and working parts for excessive wear.
						(3) Keep machine and surroundings clean.
		6				*e.* CHECK GAS-DOME SEAL. See that seal in gas dome is filled with water, light oil, or kerosene. When water is used, add antifreeze if freezing temperatures are expected.
		7				*f.* LUBRICATE DRIVE MECHANISM. Lubricate reducers and drive mechanism in accordance with manufacturer's instructions attached to unit. For proper lubricants, see paragraph 7 and table V.

Abbreviations: D, means daily; W, weekly; M, monthly; Q, quarterly; S, semiannually; A, annually.



1. Scum breaker.
2. Chain guard.
3. Driven sprocket.
4. Roller chain.
5. Driving sprocket.
6. Gear motor.
7. Blades.
8. Overflow-chamber cover.
9. Manhole cover.
10. Scum baffle cover.
11. Gas dome.
12. Worm-gear cover.
13. Shaft sleeve.
14. Scum-breaker arm.
15. Scum-arm spider.
16. Scum-arm spacer.
17. Center spacer.
18. Vertical shaft.
19. Tie-rod spacer.
20. Adjusting bolt.
21. Sag rod.
22. Long rake arm B.
23. Rake arm spacer.
24. Spider.
25. Long rake arm A.
26. Arm hinge.
27. Lower guide bearing.
28. Center scraper.
29. Blade (long).
30. Upper and lower strip liners.
31. Inner strip liner.
32. Worm gear.
33. Felt oil seal.
34. Outer strip liner.
35. Gear housing.
36. Balls.
37. Gear-housing cover.
38. Worm cover.
39. Countershaft.
40. Bushing.
41. Worm.
42. Pointer.
43. Thrust ball bearing.
44. Oil seal.
45. Oil-seal retaining plug.
46. Adapter cylinder.
47. Spring seat.
48. Housing.
49. Adjusting plates.
50. Terminal block.
51. Overload-alarm thrust spring.
52. Tail-spring seat.
53. Adjusting bolt.
54. Switch lever.
55. Housing cover.
56. Mercury switches.

Figure 47. Dorr fixed-cover digester.

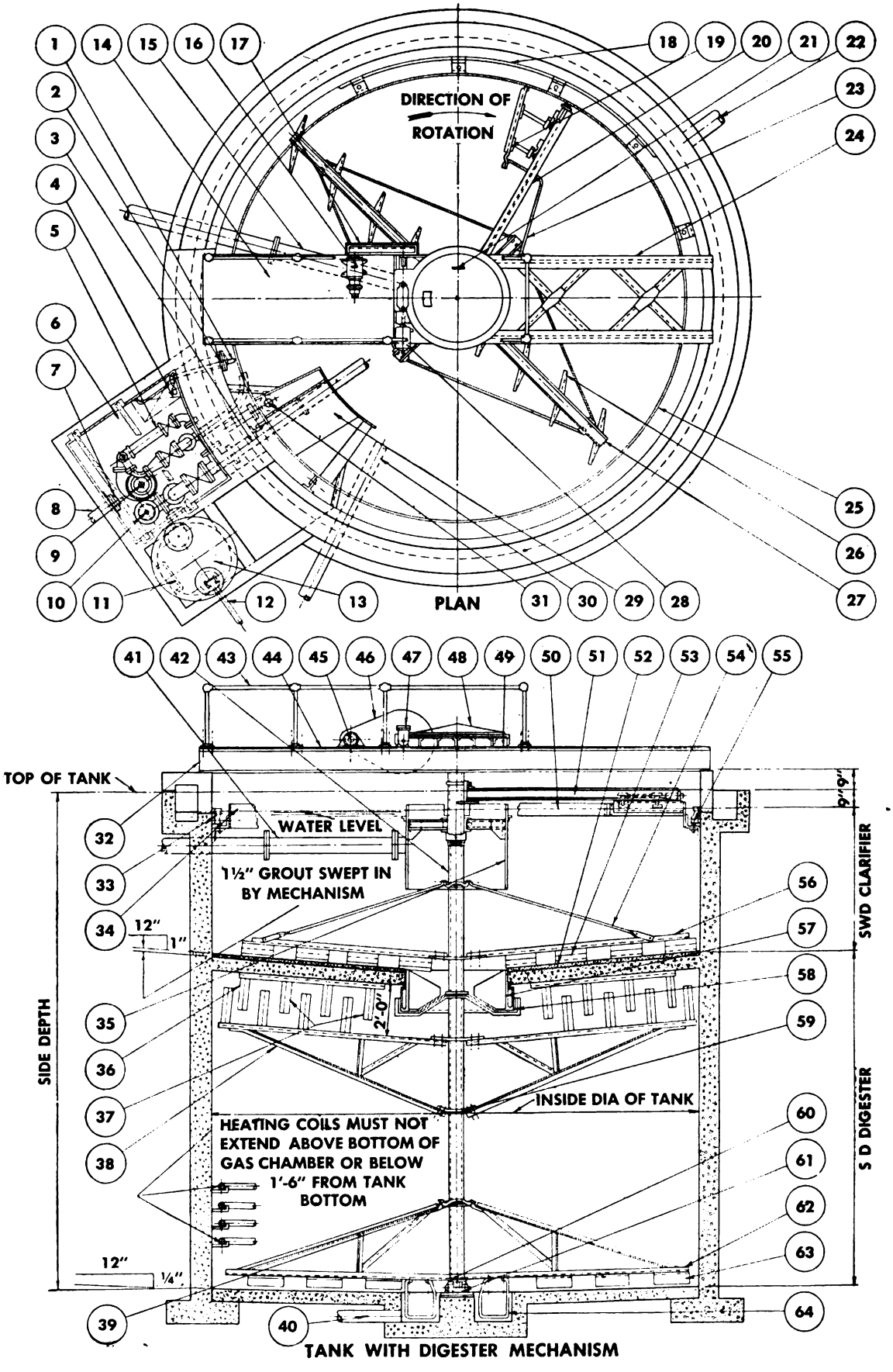


Figure 48. Dorr clarigester.

1. 2″ Scum return to influent well.
2. 6″ Sluice gate.
3. 6″ Supernatant return to influent well.
4. Access opening.
5. 2″ scum return to influent well.
6. Scum pit.
7. 6″ sluice gate.
8. 6″ drain pipe.
9. Scum pump.
10. 6″ adjustable supernatant overflow.
11. Ladder rungs.
12. 2″ gas line.
13. Gas dome.
14. Walkway.
15. Influent.
16. Drive unit.
17. Chain guard.
18. Effluent weir.
19. Skimming blade.
20. Skimming arm.
21. Drive head.
22. Effluent pipe.
23. Skimming blade.
24. Mechanism support.
25. Scum baffle.
26. Blades.
27. Rake arm.
28. Overload alarm.
29. Scum trough and shelf.
30. Sluice pipe to pump.
31. Scum drain to pit.
32. Mechanism support.
33. Weir.
34. Scum baffle.
35. Influent well.
36. Stationary scum breaker.
37. Pickets.
38. Scum-breaker arm.
39. Tie-rod spider.
40. Sludge pipe.
41. Influent pipe.
42. Center shaft.
43. Handrail.
44. Walkway.
45. Drive unit.
46. Chain guard.
47. Overload alarm.
48. Worm-gear cover.
49. Drive head.
50. Skimming blade.
51. Skimming arm.
52. Squeegees.
53. Blades.
54. Tie rod.
55. Weir.
56. Rake arm.
57. Tray sleeve.
58. Boot.
59. Spider.
60. Spider.
61. Lower guide bearing.
62. Rake arm.
63. Blades.
64. Center scraper.

Figure 48. Dorr clarigester—Continued.

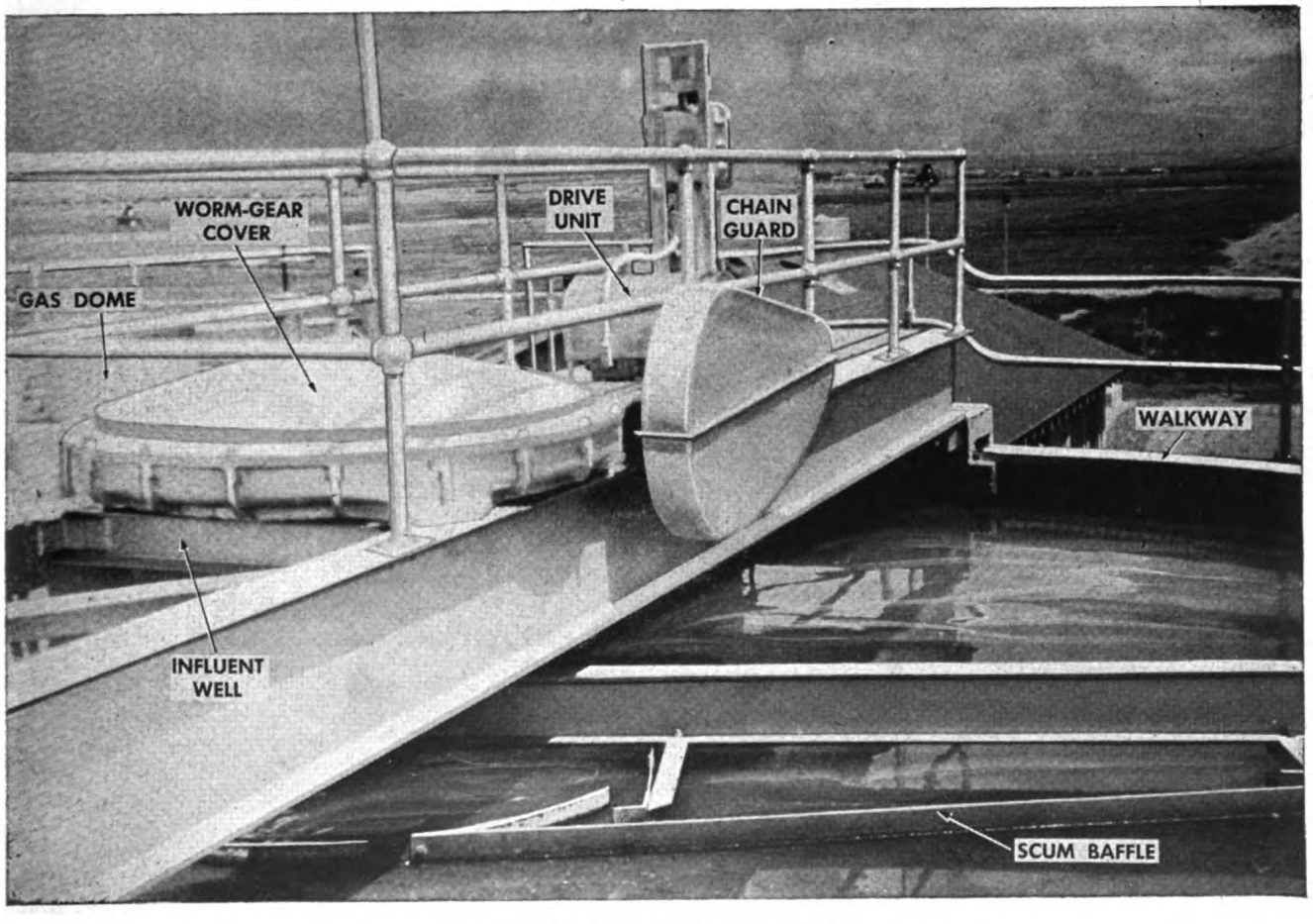
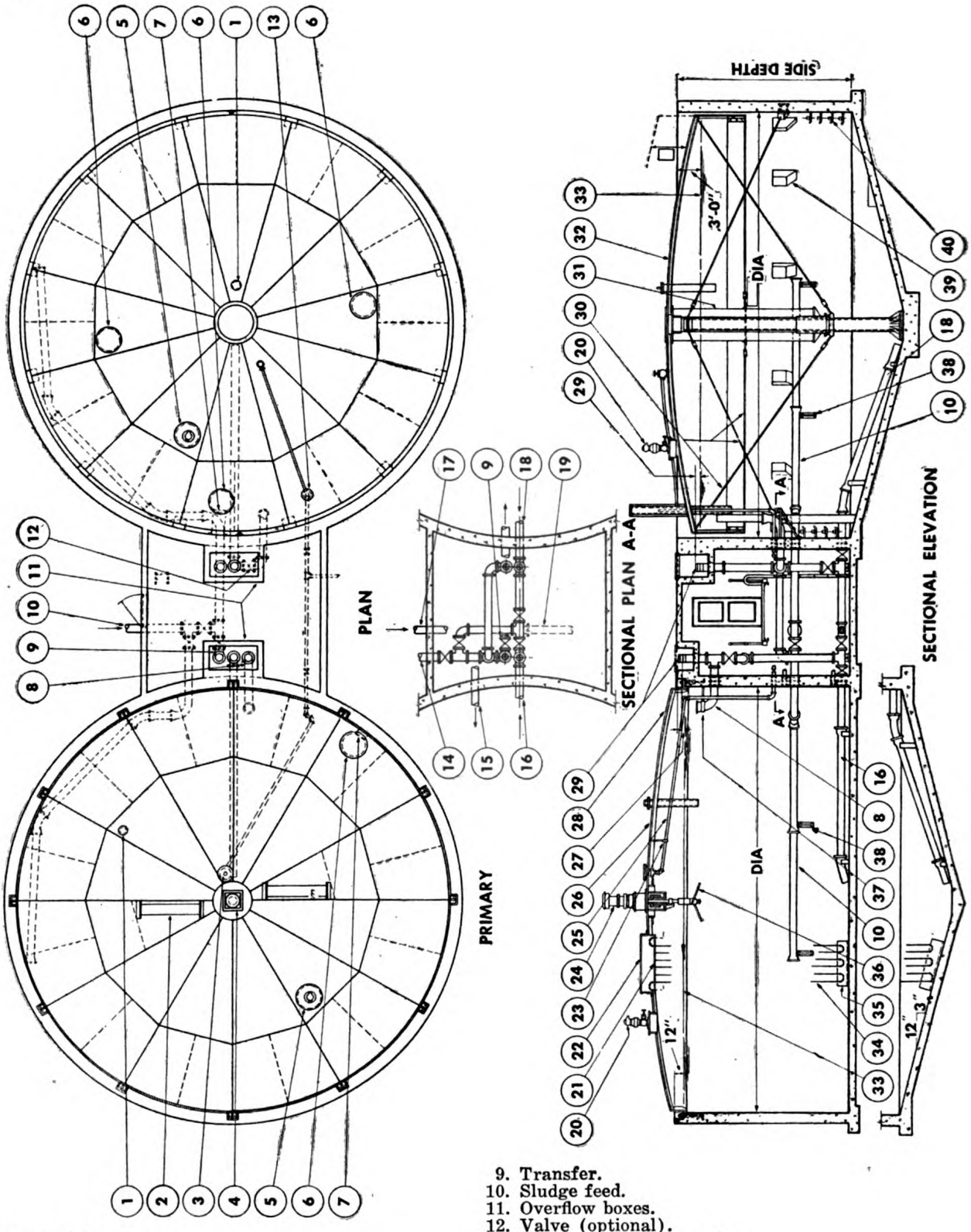


Figure 49. Clarigester installation.



1. Sample tube.
2. Heat-exchanger support.
3. Handhole.
4. Mixer.
5. Pressure-vacuum relief vent.
6. Manhole.
7. Steps.
8. Supernatant overflow.
9. Transfer.
10. Sludge feed.
11. Overflow boxes.
12. Valve (optional).
13. Scum bonnet for gas pipe.
14. Supernatant return.
15. Sludge feed to primary.
16. Sludge transfer and withdrawal.
17. Raw sludge feed.
18. Sludge withdrawal.
19. Drain to sludge beds (optional).
20. Relief vent.

Figure 50. Dorr multidigestion system.

D | W | M | Q | S | A

8

10

2

*

g. CHECK OIL IN SPEED REDUCERS. Inspect oil in speed reducers and oil baths, and change if necessary.

h. CHANGE OIL IN SPEED REDUCERS. Use NS 6125 oil in summer and replace with NS 3080 in winter.

i. CHECK MECHANICAL PARTS ON CLARIGESTER. (1) See that drive unit is always lubricated; see paragraph 7 and table V for correct lubricants.

(2) Inspect and tighten all bolts. Maintain original alignments of machine.

(3) Test overload-alarm bell and cutout switch by raising overload pointer and noting whether bell and switch operate.

(4) Examine gears and working parts for excessive wear.

j. CHECK MOTOR CONDITION. See paragraph 14.

k. CHECK IF OVERLOAD OCCURS. If foreign objects such as tools, samplers, and the like are dropped into tank, stop mechanism immediately and remove them. If overload device stops mechanism, determine and eliminate cause before starting unit again. Do not tamper with overload-switch adjustments to force machine to operate against overload. Remove drive chain from motor, back up worm by hand for 10 or 15 turns, and start mechanism. If overload is still indicated, empty tank and remove obstruction. To overcome overload caused by sand and grit accumulating in digester, remove several feel of sludge from digester.

82. Dorr Multidigestion and Multidigester Type Units (figs. 50 and 51)

15

a. LUBRICATE SPEED REDUCER. Use NS 2075 below 0°F.; NS 2110, 0°F. to 40°F.; NS 2135, 40°F. to 100°F.

14

b. LUBRICATE THRUST BEARING. Thrust roller bearing is located under large flexible coupling. To lubricate, add small quantity of BR grease through Alemite fitting in side of bearing housing. Forcing too much grease into housing may damage bearing or force out shaft seals. Remove fitting after adding grease, and run mixer for a few minutes to expel excess grease. To prevent unskilled operators from applying grease gun too often, plug hole with ordinary pipe plug until next lubrication period.

11

c. LUBRICATE STEADY BEARING. If mixer shaft has only one propeller near top of tank, there is a sleeve type steady bearing under cover. Lubricate bearing with CG 1 grease, added through grease pipe brought up above cover plate.

15

d. LUBRICATE BUSHING. If mixer shaft is extended close to tank bottom, it carries another impeller below which steady bearing is located. This bearing has a nonmetallic water-lubricated bushing. Before tank is filled and whenever it is drained, apply GG graphited grease liberally.

12

e. LUBRICATE BRONZE BUSHING ON LOWER BEARING. Grease with CG 1 added through grease piping brought through cover plate.

13

f. LUBRICATE ROLLER BEARING. Apply BR grease to roller bearing which is just above bushing.

*

g. CHECK MOTOR CONDITION. See paragraph 14.

21. Heat-exchanger support.
22. Support cover.
23. Pipe hangar.
24. Drive unit.
25. Gas pipe.
26. Gas dome.
27. Gas-pressure-developed inches of water.
28. Access manhole.
29. Overflow rings.
30. Tie rods.
31. Column.
32. Gas holder.
33. Water level.
34. Heat exchanger (shown out of projection)
35. Support angles.
36. Propeller.
37. Slope.
38. Pipe bracket.
39. Corbel.
40. Heating coils (optional).

Figure 50. Dorr multidigestion system — Continued.

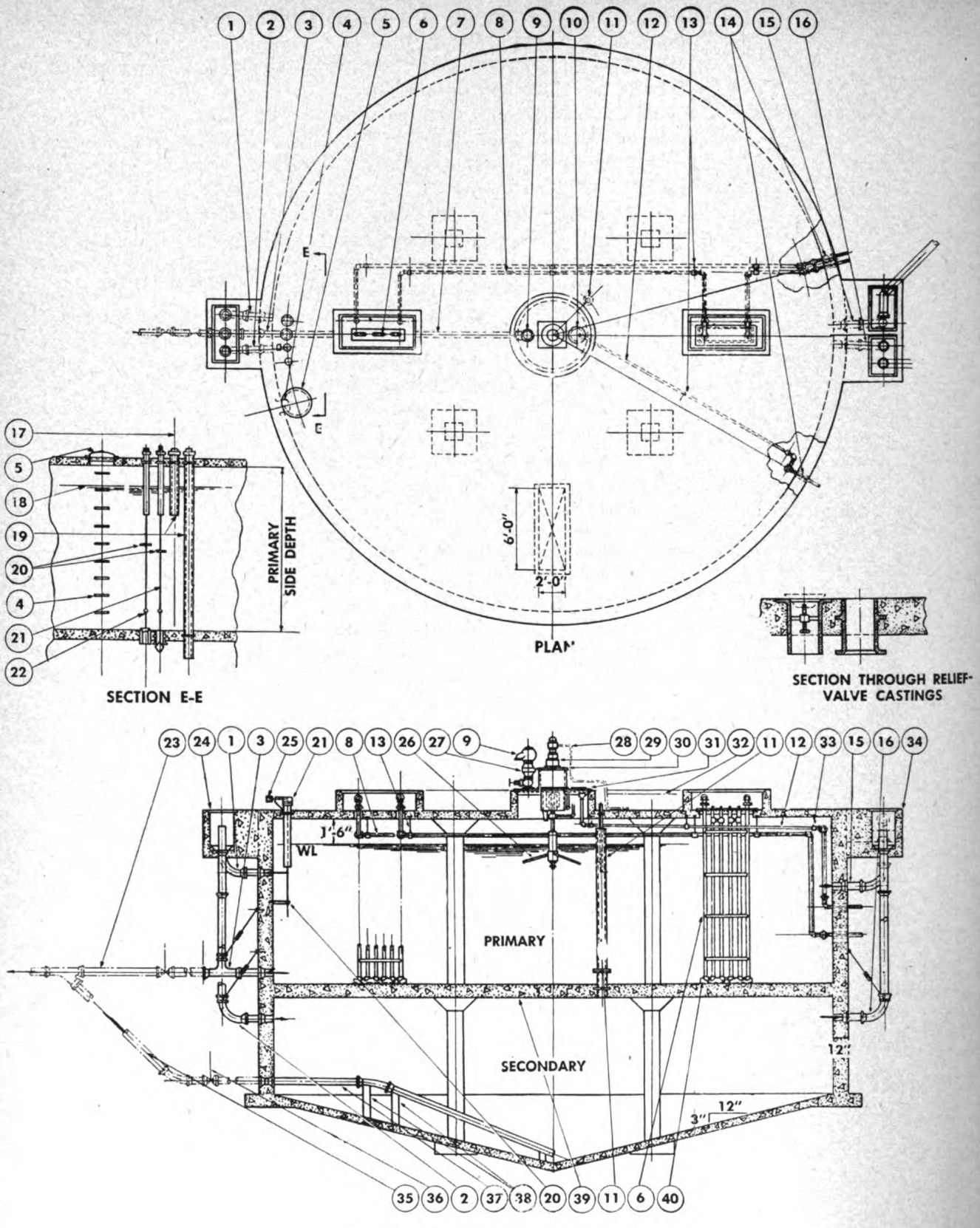
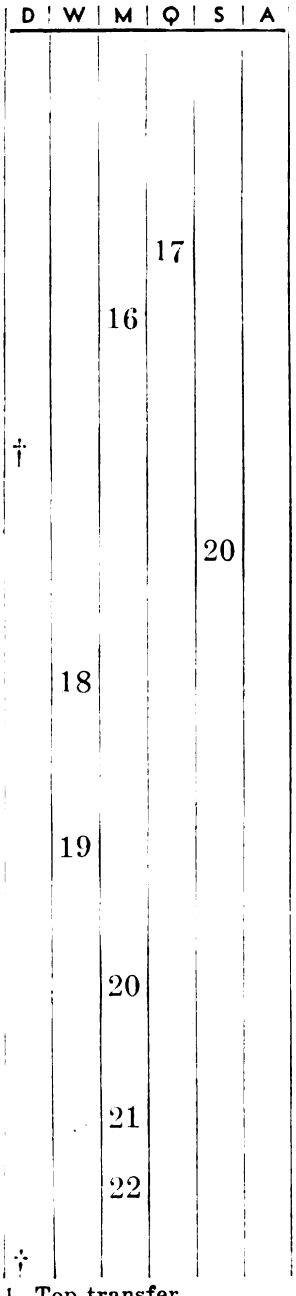


Figure 51. Dorr multidigester.



83. Infilco Digester Type Units

Operate digester mechanism continuously, stopping only when absolutely necessary. During prolonged idle periods sludge may settle and pack, causing overload device to stop motor when equipment is started. In this case, loosen packed sludge with hose or other means before attempting to resume operation.

a. CHECK OVERLOAD CONTROL. Raise overload pointer and note whether bell and switch operate.

b. CHANGE OIL IN REDUCER. Use OE 10 in reducer in winter and NS 3050 in summer. During the winter, oil may congeal if digester mechanism stands idle long; as a result mechanism will not start. Therefore, do not allow mechanism to be idle unless absolutely necessary.

c. CHECK MOTOR CONDITION. See paragraph 14.

84. Pacific Flush Tank Floating-Cover Type Units (figs. 52 and 53)

a. INSPECT FOR RUSTING. Check for rust or corrosion in floating-cover steel work under wood roof deck. Repaint if necessary. Steel work in contact with sludge becomes coated with a lardlike layer which protects paint and makes maintenance unnecessary.

b. CHECK FOR WATER ON TOP OF CEILING PLATE. Do not permit water to stand on top of ceiling plate of cover. Examine top of ceiling plate through sump access wells or entrance hatch. If water is found under the roofing draw it off through sump access wells with pitcher pump or siphon. Check roofing and ceiling plate for leaks.

c. CHECK PRESSURE-RELIEF VALVE. Make sure pressure-relief valve functions properly. (See pars. 86 and 87.)

85. Yeoman's-Simplex Type Units

a. LUBRICATE WORM AND GEAR. Fill oil reservoir in worm stand with NS 3050 in ordinary temperatures and OE 10 in temperatures near or below freezing. Set glass oiler at proper elevation to keep oil level in reservoir just below opening for gear.

b. GREASE BEARINGS. Keep grease cups on worm bearings and roller thrust bearing for main drive shaft filled with BR grease.

c. LUBRICATE REDUCTION GEARS. For proper lubricant for reduction gears, see paragraph 7 and table V.

d. CHECK MOTOR CONDITION. See paragraph 14.

1. Top transfer.
2. Transfer to secondary.
3. Bottom transfer.
4. Ladder rungs.
5. Manhole, 20″ dia.
6. Heat exchanger.
7. Sludge drawoff.
8. Heating pipes.
9. Relief vent.
10. Handhole.
11. Gas-escape pipe and flushing pipe.
12. Gas line.
13. Hanger.
14. Standard steel-pipe inserts.
15. Inlet.
16. Supernatant from secondary.
17. Tank.
18. Waterline.
19. Sample tubes, 6″.
20. Guide.
21. Downward-pressure-relief valve.
22. Upward-pressure relief valve.
23. To sludge beds.
24. Transfer box.
25. Counterweight.
26. Propeller.
27. Flame arrester.
28. Electric conduit.
29. Drive unit.
30. Reducer base.
31. Gasket and support plate.
32. Center line of tee.
33. Hanger.
34. Feed and supernatant box.
35. Sludge drawoff, offset so valve stem clears bottom transfer.
36. Valve stem.
37. Sludge drawoff.
38. Concrete piers.
39. Precast slab, to withstand hydrostatic pressure of 4′ of water plus its own weight.
40. Support.

Figure 51. Dorr multidigester—Continued.

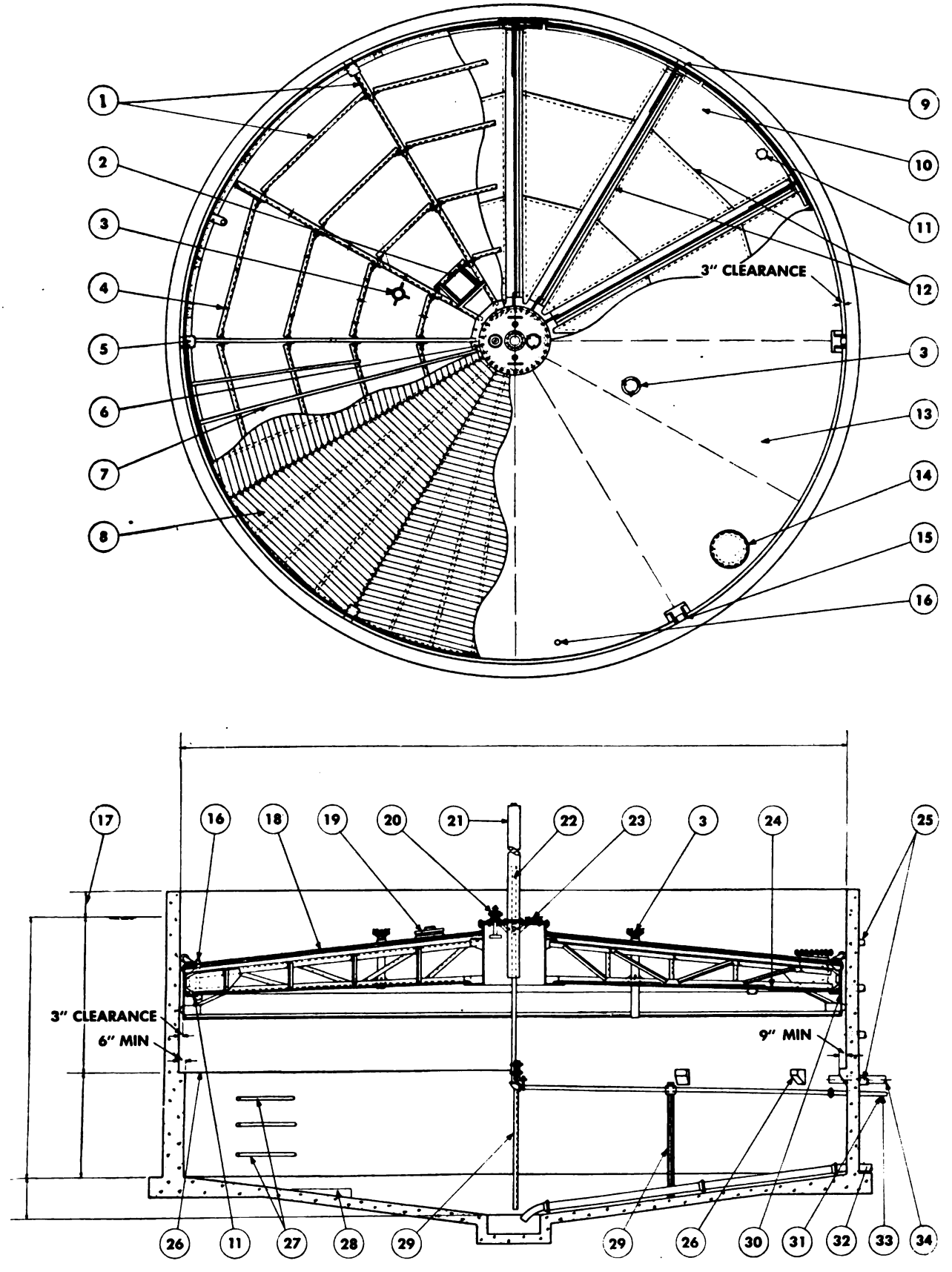


Figure 52. PFT floating-cover digester.

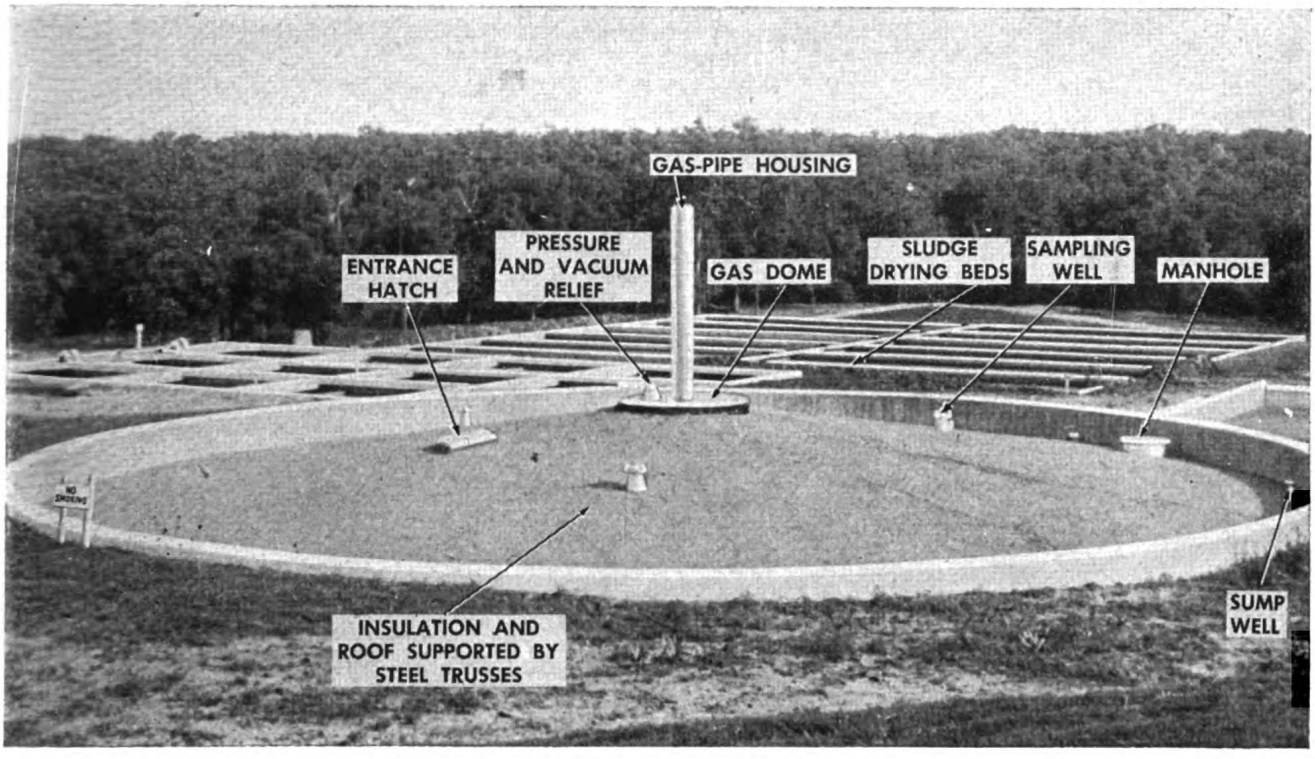


Figure 53. Floating-cover installation.

1. Section showing trusses and purlins.
2. Entrance-hatch frame.
3. Sampling well.
4. Holes in trusses and purlins for bolting rafters.
5. Top-roller support.
6. Gas dome.
7. Section showing rafters.
8. Section showing tongue-and-groove sheathing.
9. Lower roller.
10. Section showing ceiling-plate construction.
11. Drain sump (minimum of three).
12. Field weld.
13. Section showing composition roofing.
14. Manhole.
15. Top roller.
16. Sump well.
17. Freeboard.
18. Composition roofing, sheathing and rafters.
19. Entrance hatch.
20. Pressure and vacuum relief.
21. Gas-pipe housing.
22. Gas pipe. Must be accurately and securely centered in tank, with top or gas pipe 4′–0″ above maximum liquid level.
23. Handhole.
24. Ceiling plate.
25. Supernatant drawoffs and overflow.
26. Landing ledge or brackets.
27. Heating coils.
28. Recommended bottom slope about 1 in 6.
29. Gas-piping support.
30. Rim plate.
31. Gas take-off.
32. Sludge drawoff.
33. Install flame trap and pressure relief, provide drip trap at low point.
34. Sludge inlet.

Figure 52. PFT floating-cover digester—Continued.

SECTION XVII

BOILERS, GAS BURNERS, AND APPURTENANCES

D	W	M	Q	S	A

86. Pacific Flush Tank Relief Assemblies

a. PRESSURE-VACUUM-RELIEF ASSEMBLY. The weight of the floating cover on a Pacific flush tank (fig. 53) is normally equal to the pressure of a 5- to 6-inch water column. Heavy roof construction or ballast may raise the pressure to 9 inches or more. Beyond maximum pressure of 10 inches gas accumulates beneath the ceiling plate. Set pressure-vacuum-relief unit at gas dome to operate pressure-relief valve ½ to 1 inch below this maximum permissible pressure. If floating cover does not stay level in tank, reduce relief pressure. If gas wastes most of the time at pressure-relief unit, adjust pressure relief to waste-gas burner to obtain normal operation.

5 (1) *Check relief pressure.* Key numbers in discussion below refer to figure 54. Check relief pressure and adjust if necessary by adding or removing weights (4) above diaphragm (3). To reach diaphragm, remove ⅜-inch nuts (7) between flame-cell housing (6) and upper diaphragm housing (11) and lift out entire upper assembly, including top cone (8) and ¾-inch fill pipe (1). Weight of weight holder (9) and valve ring (10) equals pressure of a 2-inch water column. Cast-iron weights have values equivalent to ¼-, ½-, and 1-inch water columns; lead weights, equivalent to a 4-inch column, are sometimes available. Standard construction of unit contemplates maximum relief pressure of 10 inches.

6 (2) *Service leather diaphragm.* Since leather diaphragm (3) is surrounded by gas saturated with water, it is always moist. To prolong diaphragm life keep drain holes (12) through valve ring (10) open and treat diaphragm with neat's-foot oil.

4 (3) *Service relief valve.* Gas produced at digester, particularly during initial operation, may coat relief valve (2) with slime. Inspect valve surfaces and clean them thoroughly.

1 (4) *Check gas-dome vent opening.* If, after floating cover comes to rest on its supports, sludge or supernatant liquid is withdrawn from sludge-digestion tank without first opening a vent at the gas dome, sealing liquid is sucked out of vacuum relief when vacuum of 4 inches is reached. If this occurs, refill reservoir (13) before digester is returned to service. To refill reservoir, pour 1 gallon of kerosene or OE 10 through plug (5) in top of flame-cell cover. If gas is produced at rapid rate in digester, open handhole in top plate of gas dome to relieve pressure and permit sealing at reservoir.

2 (5) *Check liquid level in reservoir.* Check liquid level reservoir and add kerosene or OE 10 as required.

3 (6) *Service flame cell.* Examine cell to make sure that passages are open and permit free flow of air or gas. If flame cell becomes filled with slimy material during initial operation, remove slime with high-pressure water or compressed air. If gas is allowed to waste at pressure-vacuum-relief unit for long, in cold weather, hoarfrost may form. This must be removed to

Abbreviations: D, means daily; W, weekly; M, monthly; Q, quarterly; S, semiannually; A, annually.

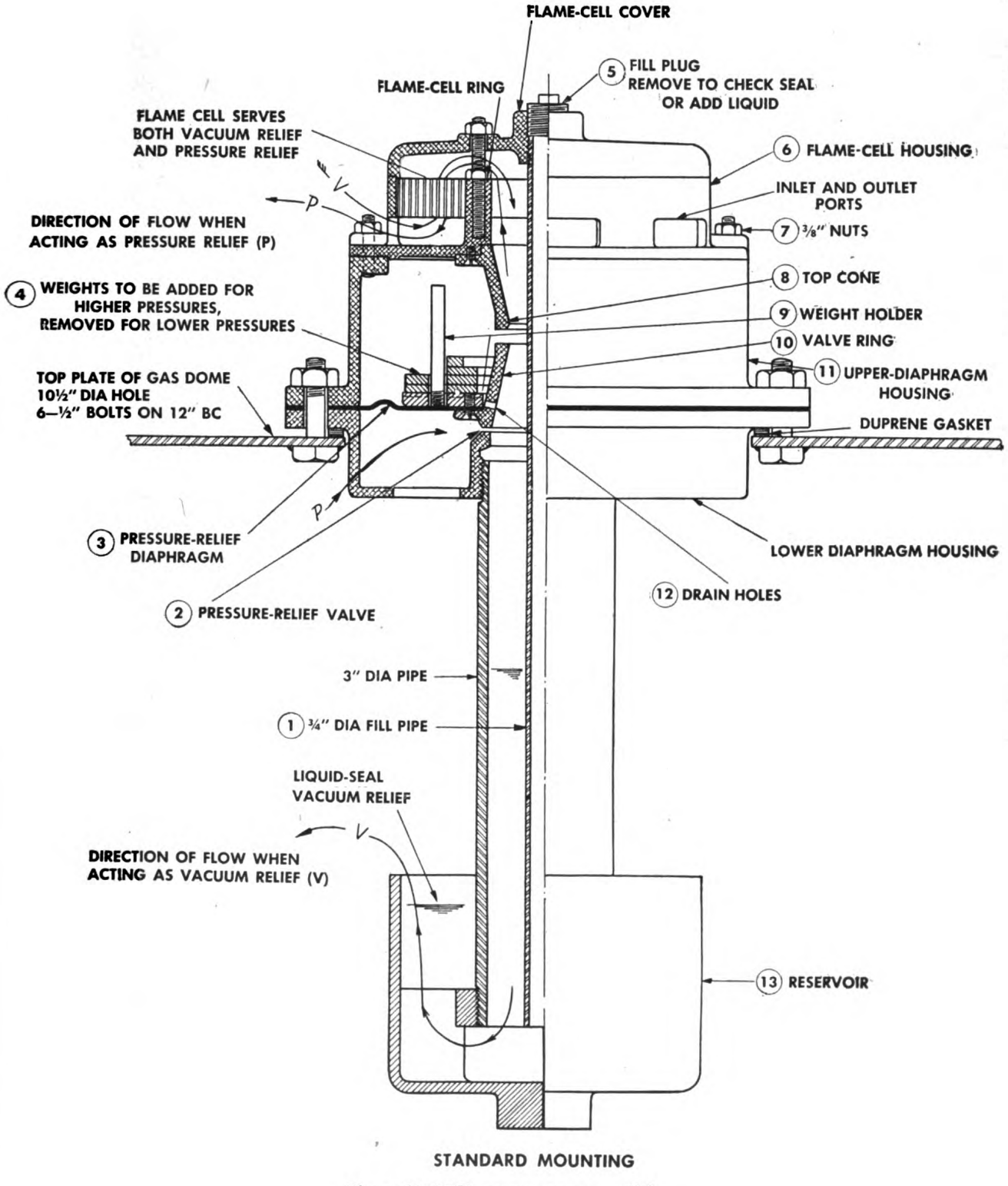
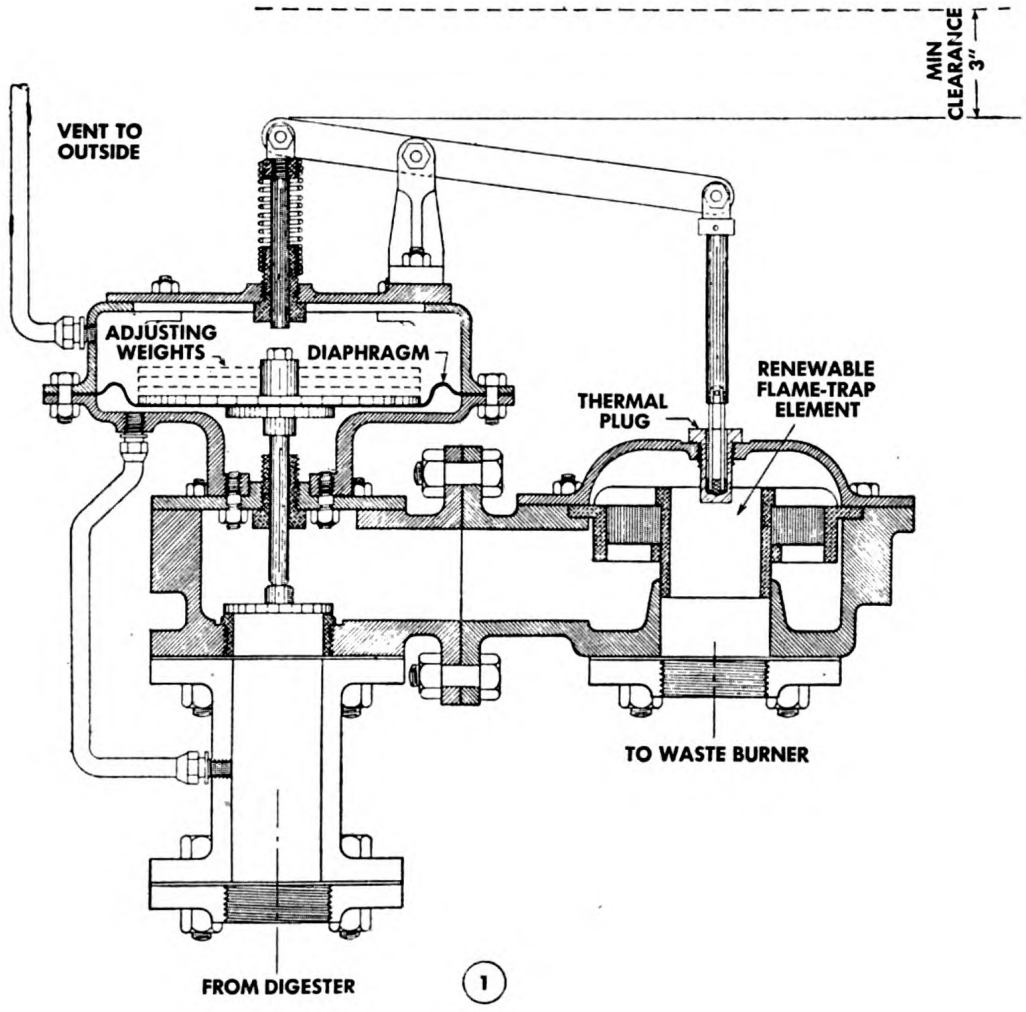


Figure 54. PFT pressure-vacuum relief.

D	W	M	Q	S	A	
						keep unit open. Pressure-vacuum-relief unit is only an emergency relief; if it is continually in service, improper setting of manually operated pressure relief to waste-gas burner is indicated. Check and adjust to lower relief pressure as necessary.
				7		*b.* PRESSURE-RELIEF WASTE-GAS FLAME TRAP (fig. 55). (1) *Check relief pressure.* Adjust relief pressure as necessary by removing cover over diaphragm and adding or removing weights. (See fig. 55①.)
				8		(2) *Service leather diaphragm.* Treat diaphragm with neat's-foot oil. Apply OE 10 to valve stem. Inspect valve parts for cleanliness.
				9		(3) *Check vent.* Make sure vent line to outside is open to permit free diaphragm motion.
				10		(4) *Check pressure drop through flame cell.* If drop is excessive, remove flame cell cover and clean passages.
				11		(5) *Service drip-trap insert-valve seat.* Check for tightness. Turn handle to open outlet port and close inlet port from gas line. Remove reservoir casting and clean out sediment. Tighten spring by turning adjustment nut until proper pressure is exerted on ring gasket. Lock in this position with locknut, replace reservoir, and resume normal operation.
				12		(6) *Check gas-line grade.* Examine gas piping from digester dome to drip trap for sag in which moisture may accumulate.
					*	(7) *Check thermal plug.* Keep spare thermal plug on hand. If loop in thermal plug has been released by excessive heat, replace as follows: roughen ends of loop with sandpaper; place ⅜ inch of solder in bottom of plug, and heat; insert loop in cup and support it until solder hardens.

87. Varec Flame Arrester, Back-Pressure Valves, and Regulators (fig. 56)

	13					*a.* INSPECT FLAME ARRESTER ASSEMBLY (VERTICAL TYPE 50A AND HORIZONTAL TYPE 53A). (1) Turn off gas. Remove handle nuts and cover and pull out bank to predetermined stop or remove it entirely. Inspect both sides of every sheet and clean if necessary with a kerosene-moistened rag, any noncaustic solution, or a medium-hard, long-bristled brush. Use cleaning agent to suit nature of material deposited.
						(2) Replace bank. Tightening cover plate applies pressure necessary to achieve a tight fit. Tighten handle nuts evenly around entire cover to prevent warping of cover plate. Screw bronze handle nuts on the studs handtight; then give nuts a partial turn, with a short pipe fitted over nut handle.
						(3) Interval between inspections varies from 1 week to 1 month depending on nature of gas. The atmosphere is sometimes laden with solids such as earth dust, leaf fragments, small blades of grass, and lint making more frequent inspection necessary.
						Note. This unit does not require lubrication.
		15				*b.* INSPECT VALVE SEATS (pressure-relief and vacuum-breaker valves No. 20 C, nonmetallic seats; No. 205, metallic seats; and Nos. 280 and 280A, nonmetallic seats). Inspect valve seats for accumulated material, particularly waxy substances. If seating surfaces or seats are dirty, clean with a kerosene-moistened rag or other noncaustic solution. If shutoff is worn, regrind metallic seats with fine grinding compound. If removal of knurled handwheel is necessary, first back out the restricting screw.
		16				*c.* SERVICE VENT SNOUT. Examine vent snout and remove any foreign material accumulated on screen. This unit does not need lubrication.



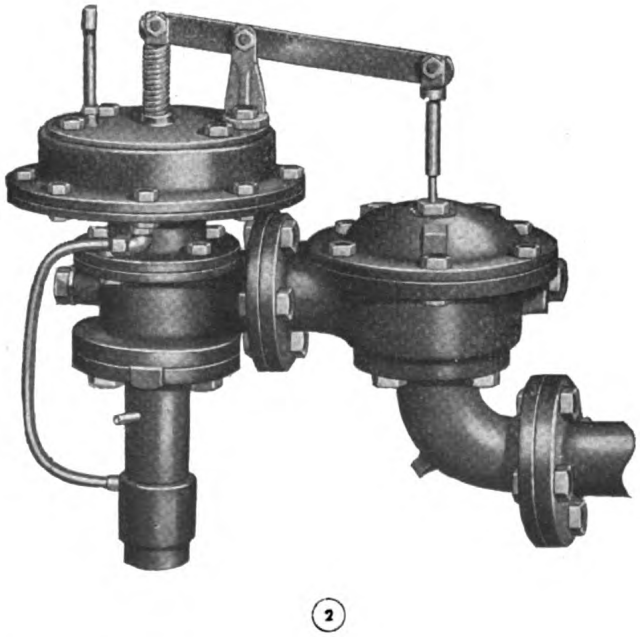


Figure 55. PFT pressure-relief waste-gas flame trap.

D	W	M	Q	S	A
				22	
		17			
		18			
				23	

d. INSPECT BACK-PRESSURE CHECK VALVE (NOS. 211 AND 211A) See *b* above.

e. INSPECT RELIEF VALVE (PRESSURE- OR EXPLOSION-RELIEF VALVE NO. 70). See *b* above.

Caution: This valve must never be installed in an inclosed space. Correct any such installation immediately.

f. INSPECT SCREENED OUTLET. Examine screened outlet and remove any foreign material accumulated on screen. This unit does not require lubrication.

g. ADJUST VALVE PRESSURE. (1) *On back-pressure regulator No. 386 and pressure-reducing regulator No. 387, single ports.* Make all valve-pressure adjustments with normal gas flow in system. To adjust pressure setting, unscrew cap and turn exposed spring-adjusting screw, until desired pressure is obtained. Turn screw clockwise to increase upstream pressure; turn counterclockwise to decrease upstream pressure. When final adjustment is made, replace cap. This does not need lubrication.

(2) *On back-pressure regulator No. 186 and pressure-reducing regulator No. 187, double ports.* Make all valve-pressure adjustments with normal gas flow in system. The following two steps are necessary in adjusting pressure setting. (See fig. 57.)

(*a*) *Coarse adjustment.* Slide counterweights (1) on rod after loosening setscrew in center of weight. Move counterweights toward diaphragm housing to increase downstream pressure; move counterweights away from diaphragm housing to decrease downstream pressure.

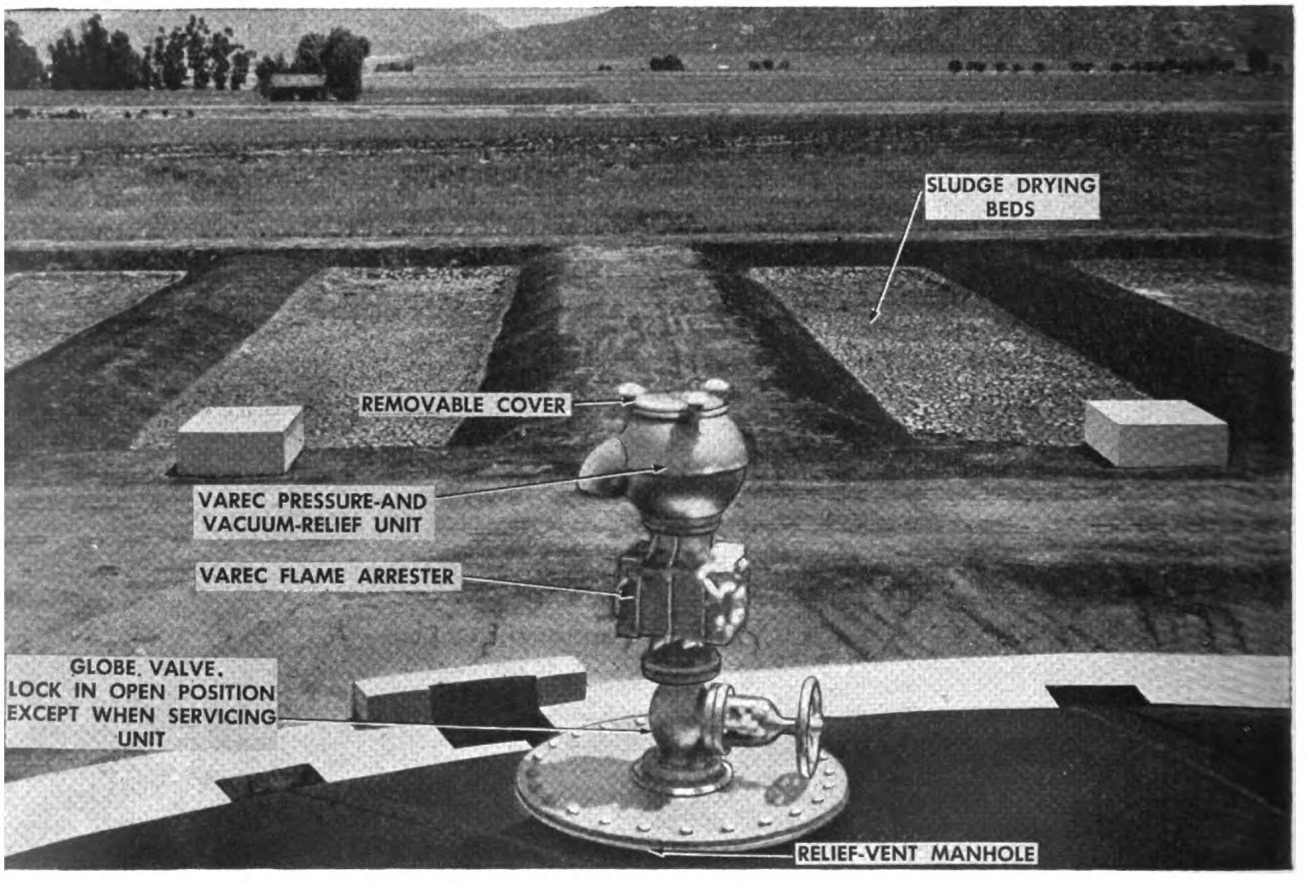


Figure 56. Pressure-vacuum relief on digester.

(*b*) *Fine adjustment.* Adjust spring by swinging inspection cover (2) over linkage arms to open position and turning adjusting screw (3) until desired pressure is reached. Turn screw clockwise to increase downstream pressure; turn counterclockwise to decrease downstream pressure. When final adjustment is made, replace inspection cover and tighten setscrews on counterweights. Do not lubricate this unit.

h. INSPECT SCREENS (FLAME CHECK NOS. 51A AND 52A). If screens are dirty, clean with any noncaustic solution.

i. INSPECT NEEDLE TRAPS AND FITTINGS (DRIP TRAPS NOS. 245 AND 248). Remove any solid matter in needle valve or fittings that may prevent proper operation of drip traps.

j. LUBRICATE INLET AND OUTLET VALVE (DRIP TRAP NO. 248). Lubricate inlet and outlet valve on drip trap with any light machine oil.

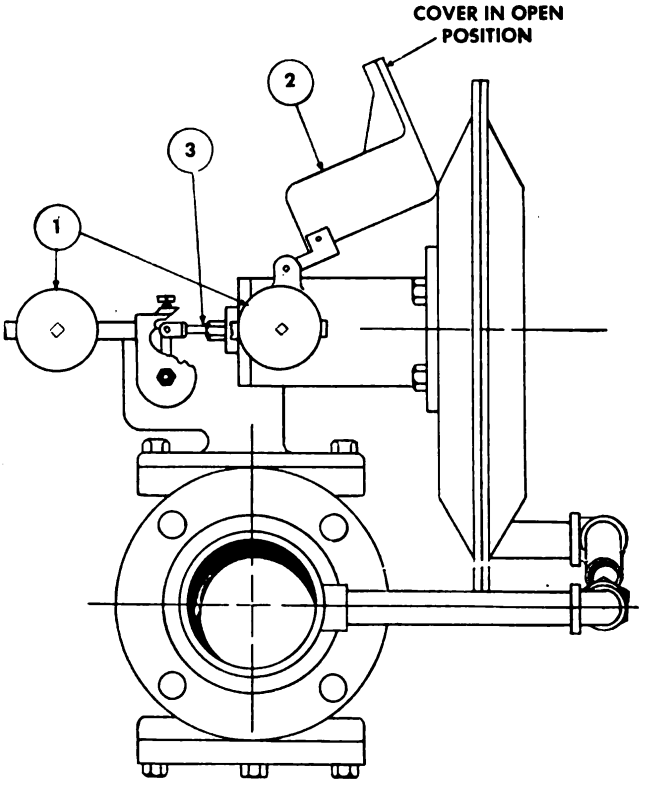


Figure 57. Varec regulator No. 187.

k. CLEAN OUT SEDIMENT (SEDIMENT TRAPS NOS. 230, 232, AND 233). Inspect sediment traps. Remove accumulated liquid through bottom drain connection; remove cleanout plate to get out accumulated solids.

88. Waste-Gas Burners

a. ADJUST PILOT VALVES AND AIR INTAKE. (Waste-gas burners Nos. 236, 237, and 238). Check adjustment of pilot valve and adjustable air-intake shutter. Maintain 2-inch pilot flame. When clogged, dismantle and clean with wire.

b. INSPECT EXHAUST VENTS. Inspect and thoroughly clean exhaust vents in the molded firebrick baffles, combustion chamber, needle pilot valve and flame nozzle. No lubrication is required.

D	W	M	Q	S	A
	26				
		27			
			28		

89. Gas-Fired Boilers

a. CHECK BOILER TEMPERATURE AND CLEAN FLUES. Maintain proper boiler temperatures, never exceeding the maximum for which boiler was designed. Clean openings between sections of boiler by scraping them and brushing with a flue brush. Clean burner parts. Avoid high gas pressure on igniting pilots to prevent their blowing out.

If boiler is out of service for a prolonged period, take precautions to keep condensation from forming on interior surfaces of boiler. Passing air through boiler is one method of preventing condensation.

b. INSPECT PILOT-LIGHT SAFETY SHUTOFF. Extinguish pilot by closing pilot valve. Main gas supply should close automatically. Relight pilot.

c. INSPECT CONTROLS. Inspect controls and correct causes of corrosion or sluggish action.

SECTION XVIII

SLUDGE-CAKE SHREDDERS

D	W	M	Q	S	A
	1				
		2			
			3		

90. Royer Type Shredders

a. SERVICE BELT. (1) See that belt runs true on pulleys at all times. Adjust belt evenly between flanges of top pulleys by nuts located on both sides of machine. Tighten or loosen these nuts so belt floats evenly between flanges; this prevents excessive wear on flanges and edge of belt. Avoid excessive stress on belt; it should be tight just enough to prevent slipping on pulleys.

(2) In feeding material into hopper, avoid throwing heavy undesirable material into machine. Do not allow undesirable material to accumulate in hopper and ride sprigs of belt. Discharge undesirable material by opening retaining plate at bottom.

(3) Before discontinuing use of shredder, clean sprigs of belt with wire brush. See that material does not accumulate on inner surface of belt and cling to pulleys.

b. LUBRICATE PULLEY BEARINGS. Add BR grease through pipe plugs on bearing cap and drive-guard support of upper pulley and on ends of shaft of lower pulley.

c. CHANGE GREASE IN PULLEY BEARINGS. Flush bearing housings and caps and clean out hardened or dirty grease. Repack half to three-fourths full with BR grease.

Abbreviations: D, means daily; W, weekly; M, monthly; Q, quarterly; S, semiannually; A, annually.

SECTION XIX

METERING DEVICES AND RECORDERS

D	W	M	Q	S	A
1					
				2	
			7		
3					
	5				
	6				
4					

91. Venturi Tubes

Maintenance procedures below apply to venturi tubes installed in gravity and pump-discharge mains.

a. SERVICE HYDRAULIC SYSTEM. Close vent-cleaner valves and flush annular chambers at inlet and throat. Flush sediment tanks and small connecting pressure piping. Vent sludge lines to release any gas that may have formed. Where continuous flushing is used, check flow indicators to make sure volume of flushing water is the same in each line.

b. EXAMINE AND CLEAN TUBE. Remove handhole covers and examine interior of tube. Clean out slime and other foreign deposits.

92. Weirs, Flumes, and Kennison Nozzles

The services below are performed on weirs, flumes, and Kennison nozzles that are installed in open channels or at the ends of partially filled pipes.

a. CHECK WEIR-PLATE ELEVATION. See that it is level.

b. SERVICE METER. Remove any deposit that may have built up on floor or side of weir structure. Examine interior of Kennison nozzle and clean out any material which may have collected.

c. SERVICE FLOAT PIPES. Drain float pipes, flush out with hose stream, and fill with clean water. Examine floats and replace those that are waterlogged. Examine cable and replace if worn or frayed. Remove cause of fraying such as rubbing on guide pulley. Inspect guide pulley and check alignment. Oil bearings with a light oil to insure free rotation. Make sure pencil-sized stream of water is continuously flowing without appreciable pressure in float pipes.

d. SERVICE STILLING BASIN. Procedure below applies to Parshall flumes or weirs equipped with Simplex meter. (See figs. 58 and 59.)

(1) Clear tailpipe connection to stilling well by rodding or water flushing.

(2) Drain stilling well by closing shutoff valves ((1) and (2), fig. 58) and opening blowoff valve (3). Supplement by flushing with water if necessary.

(3) Open drain valve in meter float well below recorder in control house and drain float well; supplement by flushing with water.

(4) Close drain valve and fill float well with water to approximately maximum operating level as indicated by meter.

(5) Open valve 3, flushing back into stilling well and to drain, thus flushing connecting line. Repeat until flow is clean.

(6) Fill meter float well and stilling basin to zero level with clear water.

Note. Frequency of this operation ranges from daily to weekly, depending on rate of fouling.

e. FLUSH WEIR CHANNEL. Clean weir box, a natural collector of sludge, by draining, flushing, or shoveling accumulations out. This is extremely

Abbreviations: D, means daily; W, weekly; M, monthly; Q, quarterly; S, semiannually; A, annually.

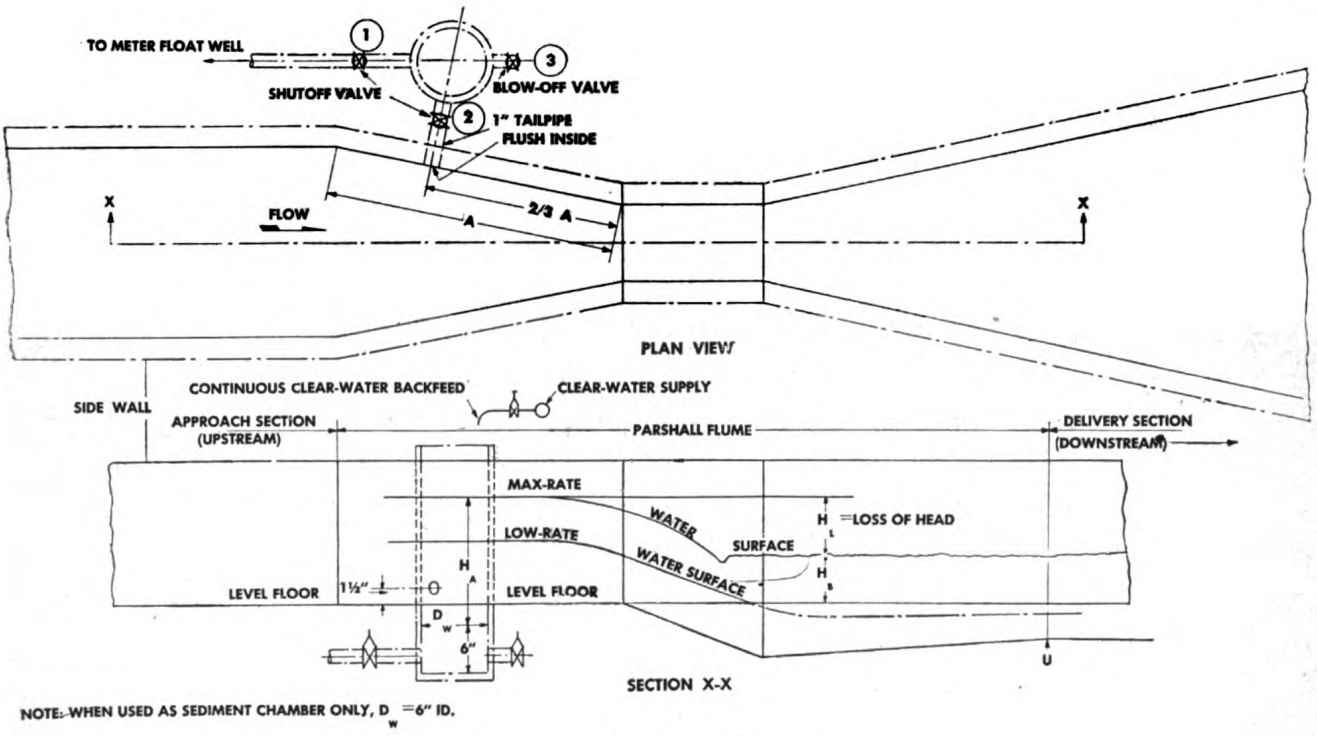


Figure 58. Parshall flume.

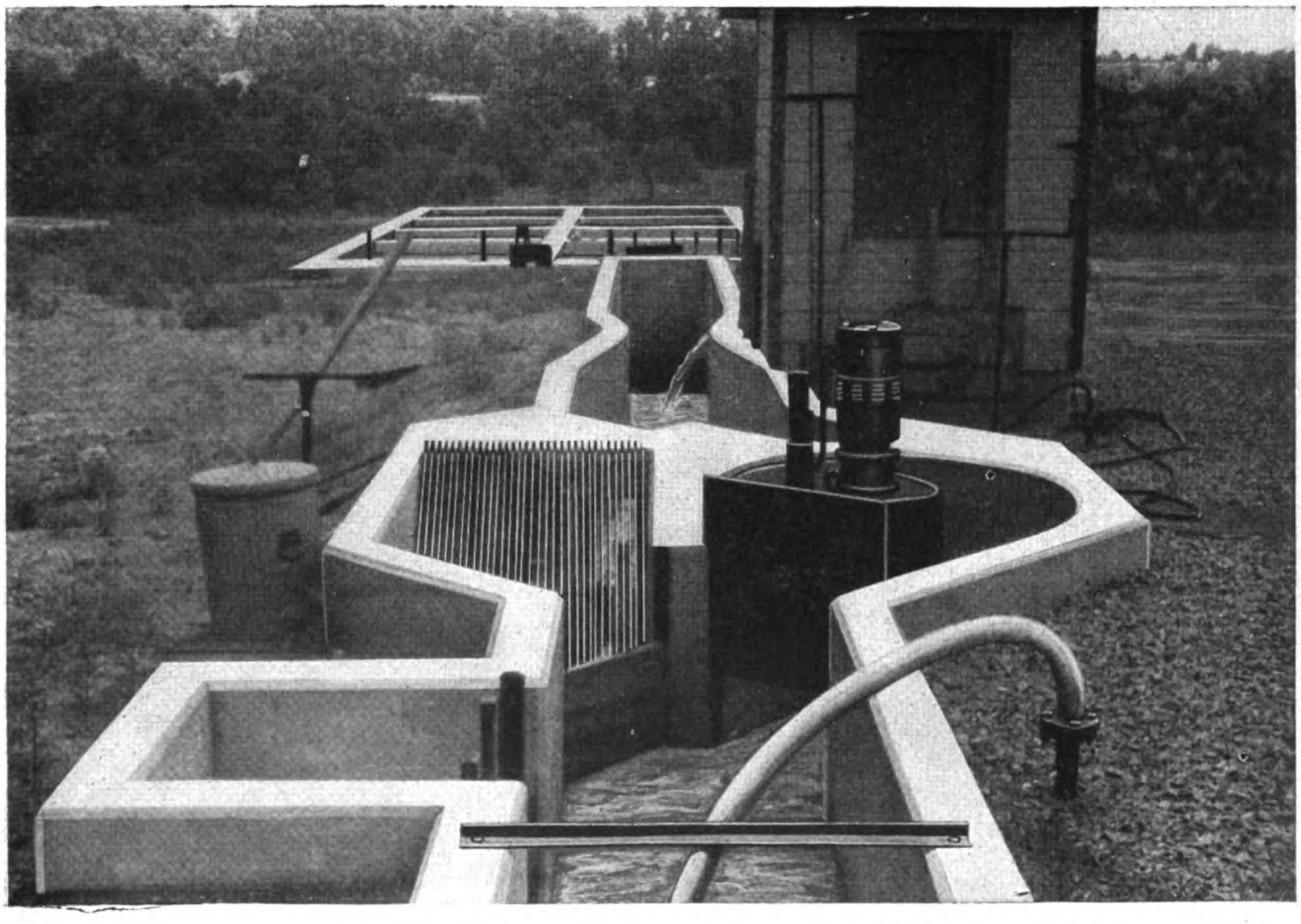


Figure 59. Screen chamber and Parshall flume-meter installation.

important, since large volume of solids at weir plate increases velocity of approach and affects contraction of issuing stream, thus modifying the accuracy of measurement.

93. Builders Iron Foundry Registers

a. AIR RELAY UNITS. (1) *Service relay units.* Flush liquid side of units with clear water. Drain air side, noting amount of water drained. If a large amount of water drains out, remove front cover and examine diaphragms for punctures or cracks. If new diaphragm is necessary, be careful not to bend needle-valve stem during installation. Examine air-input orifice and remove any foreign matter. Blow out moisture traps.

11 (2) *Service instrument.* Examine pulley shaft to be sure it moves freely. Check cam cycle of Flo-Watch and Chronoflo instruments for correct time interval, since motor may be running slow. Check counter and integrating disk of type-M instruments to be sure clock and motor are operating correctly. With cam stationary, fill oil trough of Chronoflo and Flo-Watch instrument with OCW oil to within $\frac{1}{16}$ inch of top.

14 (3) *Lubricate.* Oil all shaft and pivot bearings and other working points with Superfine instrument oil.

15 (4) *Check zero setting carefully.* Reset if necessary.

b. MERCURY-OPERATED INSTRUMENTS. (1) *Service instrument.* Inspect both pressure mercury wells. If mercury has blown over, check mercury level as described in the manufacturer's instruction book and replace any lost mercury. Use virgin mercury in type-M instruments and triple-distilled mercury in Flo-Watch and Chronoflo instruments.

12 (2) *Examine chain and chain spool.* Be sure chain in Flo-Watch and Chronoflo instruments is tracking properly. Inspect stuffing box; if it leaks when gland nut is finger-tight, repack with special packing.

16 (3) *Check zero of instruments with test pipe.* Be sure cam is in correct relation to pen and indicator of type M and Flo-Watch instruments, and mercoid switch and magnet are operating satisfactorily in the Chronoflo instrument. Check relative readings of recording pen, indicator hand, and totalizer. If readings disagree, refer to instruction book.

17 *c.* CHRONOFLO INSTRUMENTS. (1) *Service transmitters.* Check length of signal interval at various points throughout range of the instrument. Refer to manufacturer's instructions for method of correcting errors.

18 (2) *Check mercoid switch and magnet.* With transmitter trip arm riding on cam, see that magnet is far enough away from mercury switch that there is no pull on the switch. With transmitter trip arm off cam, make sure magnet pulls the movable electrode entirely clear of the mercury globule and there is no electrical contact.

25 (3) *Service receivers.* Receiver adjustment should have the services of an experienced electrician. If technical assistance cannot be made available to remedy difficulties proceed as follows:

(*a*) Check signal wires to be sure electrical impulse is being received.

(*b*) Examine armature, armature lever, and contact points.

(*c*) Clean armature face with several thicknesses of lint-free cloth saturated with carbon tetrachloride.

(*d*) Make sure armature lever has moved the increase contact $\frac{1}{64}$ inch when armature touches core. If it has not, bend one of the contact arms slightly.

D	W	M	Q	S	A
			20		
			21		
		19			
9					
			22		
			23		
10					
	13				
			24		

(*e*) Examine contact points of relay. If they are pitted or worn, replace or burnish with a contact burnisher or fine-point file.

(4) *Lubricate universal-receiver mechanism.* Use TW oil sparingly; a drop of oil will suffice. Then saturate felts until oil appears on surface.

(5) *Clean faces of clutch cups and clutch armature.* Use a lint-free cloth saturated in carbon tetrachloride.

(6) *Operate clutch armature.* Press lightly on relay armature until positive release and a sharp click is heard.

(7) *Check sediment tanks and pressure piping.* Make sure sediment tanks are full of clean water. Flush sediment tanks and pressure piping. If continuous flushing is provided, check whether flushing indicator shows correct water-flow rate, approximately 1 quart per minute.

d. TYPE-M REGISTER INDICATOR-RECORDER (fig. 60.) (1) *Service instrument.* See that instrument is level and securely fastened to floor. Make sure pressure piping connections and mercury drain screw are tight. Check whether coupling arm hub clears gland nut by at least $\frac{1}{64}$ inch.

(2) *Check cam and index.* (*a*) With line pressure acting on both mercury wells (equalized pressure) and zero stop out of the way, hold cam roller away from cam and tap instrument lightly with the hand. Note whether mark on cam lines up with index mark and whether indicator hand points to true zero on the dial. If not, consult manufacturer's instruction manual.

(*b*) With zero stop in operating position and cam held as in (*a*) above, note whether indicator hand points to *mechanical zero* and recording pen is on *zero circle* of chart. Check recording-pen movement from zero to maximum to see if it follows one of the curved lines radiating from center to rim of chart. Check that recording pen makes a clean sharp line without roughening the chart paper.

With the instrument operating properly:

1. Integrator remains motionless when recording pen is on zero circle of chart.
2. Indicator hand comes to test mark on dial when test head (fig. 61) is established on high-pressure well as described in manufacturer's instruction manual.
3. Integrator counts correct number of units when test head is acting on instrument.
4. With line pressure bypassed or acting on both mercury wells (equalized pressure) as described in instruction manual, instrument returns to zero.
5. With flow through the line and with all valves except bypass valve open, instrument shows rate of flow.

e. FLO-WATCH METER. (1) *Service instrument.* Perform services outlined in *c*(3)(*a*) to (*d*) above; make sure mercury drain screw is tight and no mercury is leaking out.

(2) *Purge mercury wells of air.* Open keyed air-bleeder cocks.

(3) *Check cam and index.* With current turned on, check that totalizer cam makes one revolution every 15 seconds. With zero stop turned up, tap instrument lightly with the hand; note whether line on cam is in line with index mark. With line pressure acting on both mercury wells as described in manufacturer's instruction manual and with zero stop in operating position, note whether recording pen is on zero circle of chart. If not, adjust. With test head acting on instrument, check whether totalizer

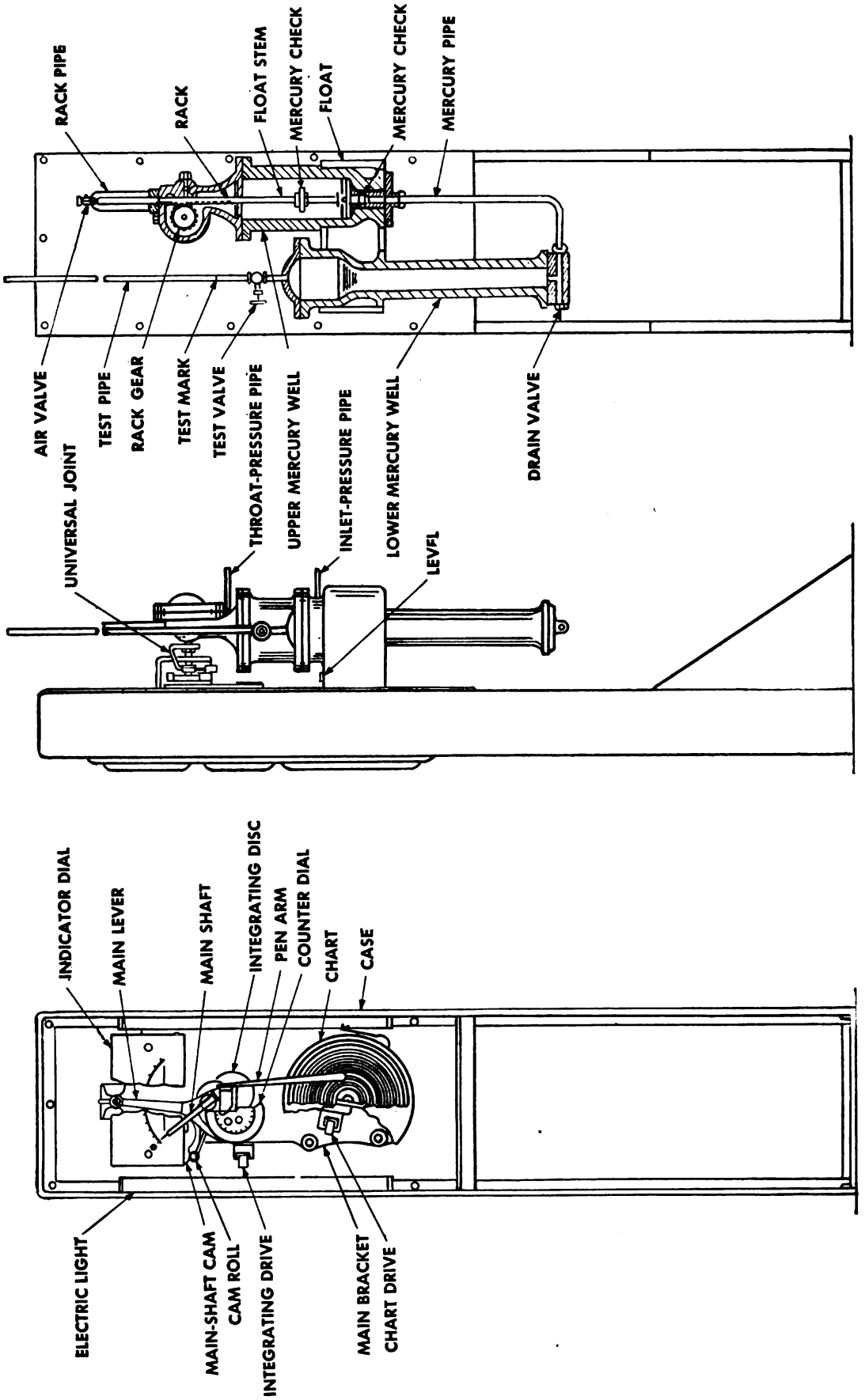


Figure 60. Builders Iron Foundry type-M indicator recorder.

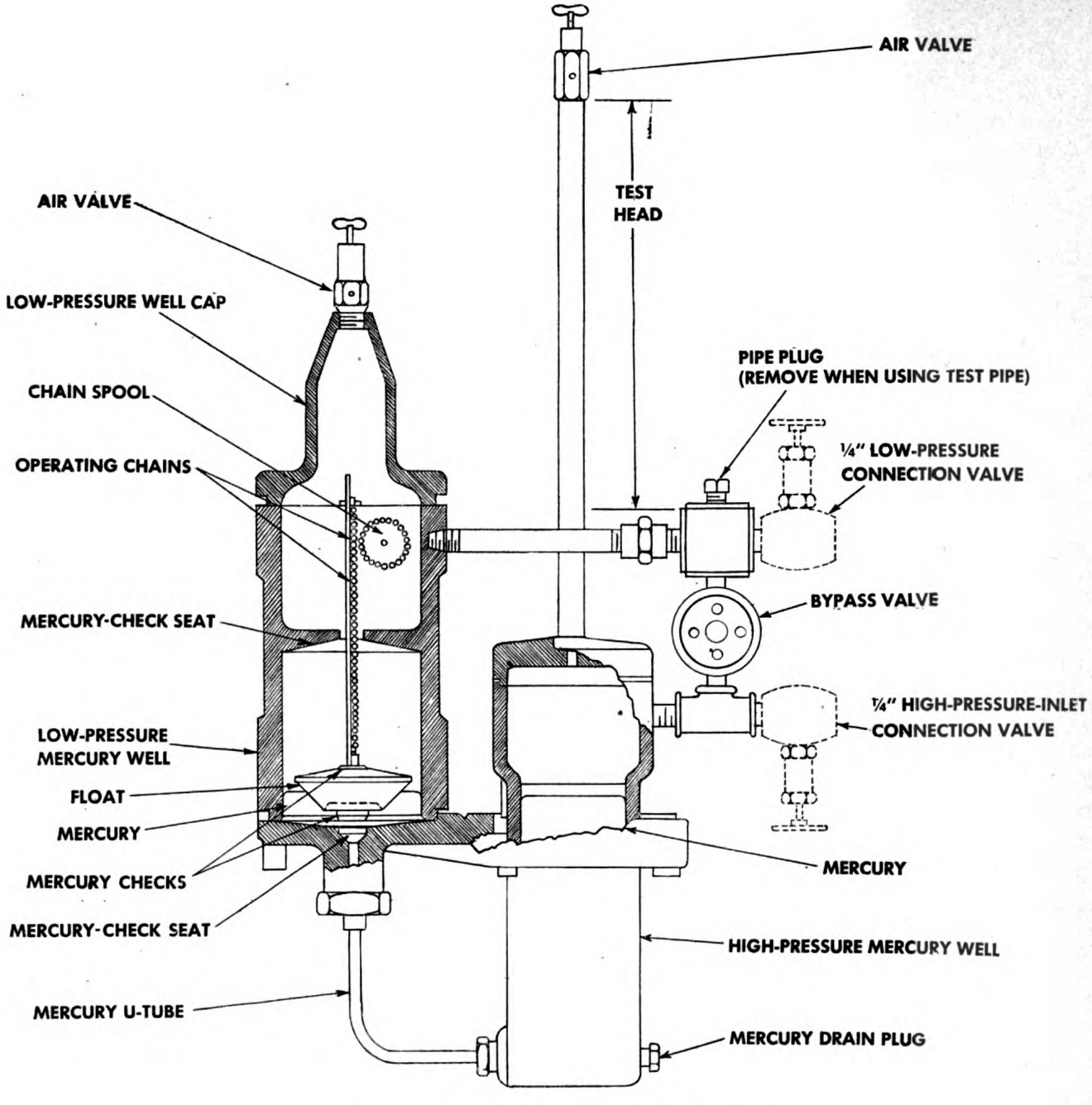


Figure 61. Builders Iron Foundry test head.

counts correct number of units as noted in instruction manual. When moving from zero to a high rate, check to see that recording pen follows one of the curved lines radiating from center to rim of chart and that indicator hand points to equivalent of recording-pen position. Inspect to see that totalizer is completely engaged when cam shoe is on cam, and completely disengaged when cam shoe is off cam. Check oil level in oil trough and add OCW oil as necessary. With flow through the line and with all valves except bypass valve open, note whether instrument indicates correct rate of flow.

94. Simplex Meters

a. FLUME FOR TYPE-S METER. (1) *Flush and inspect flume.* See that there are no excess accumulations inside surface of flume. These accumulations occur only at levels corresponding to steady flow; otherwise flume is self scouring. Operate cleaning valve to clear horizontal connection at bottom of flume, then withdraw to normal out position.

30 (2) *Service float well.* Close valve in line to meter float well. Insert ½-inch diameter wooden plug in piezometer at invert of flume. Open blowoff valve, drain, flush with clear water, and close valve. Remove wooden plug and flush through piezometer. Open drain valve of meter float well, drain float well, and flush with water. Close valve and fill float well with water to approximate maximum operating level as indicated by meter; open valve 3 (fig. 58) back into stilling basin and to drain. This flushes connecting line. Repeat until flow is clean. Fill meter float well and stilling well to zero level with clear water.

40 (3) *Lubricate meter.* If spring clocks are installed, oil only the bearing, using OCW oil. *Keep oil off friction disk of the totalizing element.* Pivots and bearing in meter assembly may be oiled sparingly. If an electric clock is installed, no oiling is necessary.

Caution: Do not attempt to oil the motor or take the case apart.

37 *b.* HIGH-HEAD METERS. (1) *Service meter.* Make sure pointer, pen, and totalizer are in calibration and pressure lines have a rising or falling grade with no air pockets. Clean pressure line of venturi tube. Keep pressure lines and meter cylinder free of air. See that pressure lines between primary device, sediment tanks, and meter cylinder are clean and filled with clean water.

Close off the two pressures at meter cylinder, open equalizing valve, remove cylinder cover, and take out float. Drain mercury out through mercury drain plug at bottom of cylinder. If mercury is dirty, wash and strain it through chamois. Flush cylinder thoroughly and clean float. If after reassembly calibration is unsatisfactory, follow detailed procedure below.

38 (2) *Check for causes of unsatisfactory operation.* (See fig. 62.)

(*a*) Air may be under float or in pressure lines.

(*b*) Float and cylinder may need cleaning.

(*c*) A pressure-line leak may have developed. If venturi tube is accessible or installed in a pit, test for leaks in buried M pressure lines by closing off M valve at the venturi tube and observing pointer on register for a few minutes. If pointer remains stationary, line is tight; if it gradually goes toward zero, line leaks. Test T line by closing off T valve at the venturi and observing pointer. If pointer gradually goes toward maximum, line leaks; if it remains stationary, line is tight.

(*d*) Setscrew in meter assembly may be loose, causing slippage.

c. LOW-HEAD METERS. (1) *Perform general service.* Since operation of low- and high-head meters is exactly the same, service low-head meters by procedure in *b* above.

(2) *Inspect links and cables.* Because of head conditions, the cylinder in a low-head meter is on a lower level than the header assembly. The two assemblies are connected by links and cables. Check links for corrosion. Examine flexible cables at meter cylinder and meter header and replace those which are unserviceable.

d. AIR-OPERATED METERS. (1) *Service venturi tube.* Free air lines of any water or condensation. Flush venting chambers and pressure belts and lines to venturi tube. Make sure proper pressure of clean dry air is delivered to the manifold.

(2) *Drain drop legs.* Draw off all condensation.

(3) *Drain air receiver.* If air-compressor storage tank is used, drain tank to remove condensation and oil. Otherwise, accumulation of condensation will reduce volume in air storage tank and make too frequent operation of the compressor necessary. In addition, excessive sediment will be carried into pressure lines.

(4) *Clean pressure belts.* Close valves M and T (fig. 63) at meter cylinder, open equalizing valve, and close valves Ct and Cm, removing meter from service. Flush venting chambers by closing valves Vm and Vt applying disconnector (fig. 64) at connections, and opening blowout valves Bt and Bm.

(5) *Examine pressure lines.* Keep pressure lines from primary device to meter cylinder clean and filled with clean water. Pressure lines and meter cylinder should not be air-pocketed.

(6) *Inspect air source.* Make sure clean dry air is delivered.

(7) *Examine distributing orifices.* To make sure orifices are free, insert shank end of a No. 80 drill (0.0135-inch diameter) after removing plugs.

(8) *Check for causes of unsatisfactory operation.* (*a*) Meter may not be in calibration.

(*b*) Air lines may not be absolutely tight. Test air lines by applying soapy water to lines and joints and watching for air bubbles which indicate leaks.

(*c*) Air tips may not be set at zero.

(*d*) Air-distributing orifices in manifold may be clogged.

95. Bailey Meters (FF35 and FF36 Types)

a. Clean float tube and float. Increase cleaning frequency if operating conditions warrant. Examine pulley system and service as often as necessary to keep it running freely. Lubricate with TW oil.

Note. Meter bearings are self-lubricating and need not be oiled.

b. Check zero setting.

c. Check calibration. Follow manufacturer's instructions

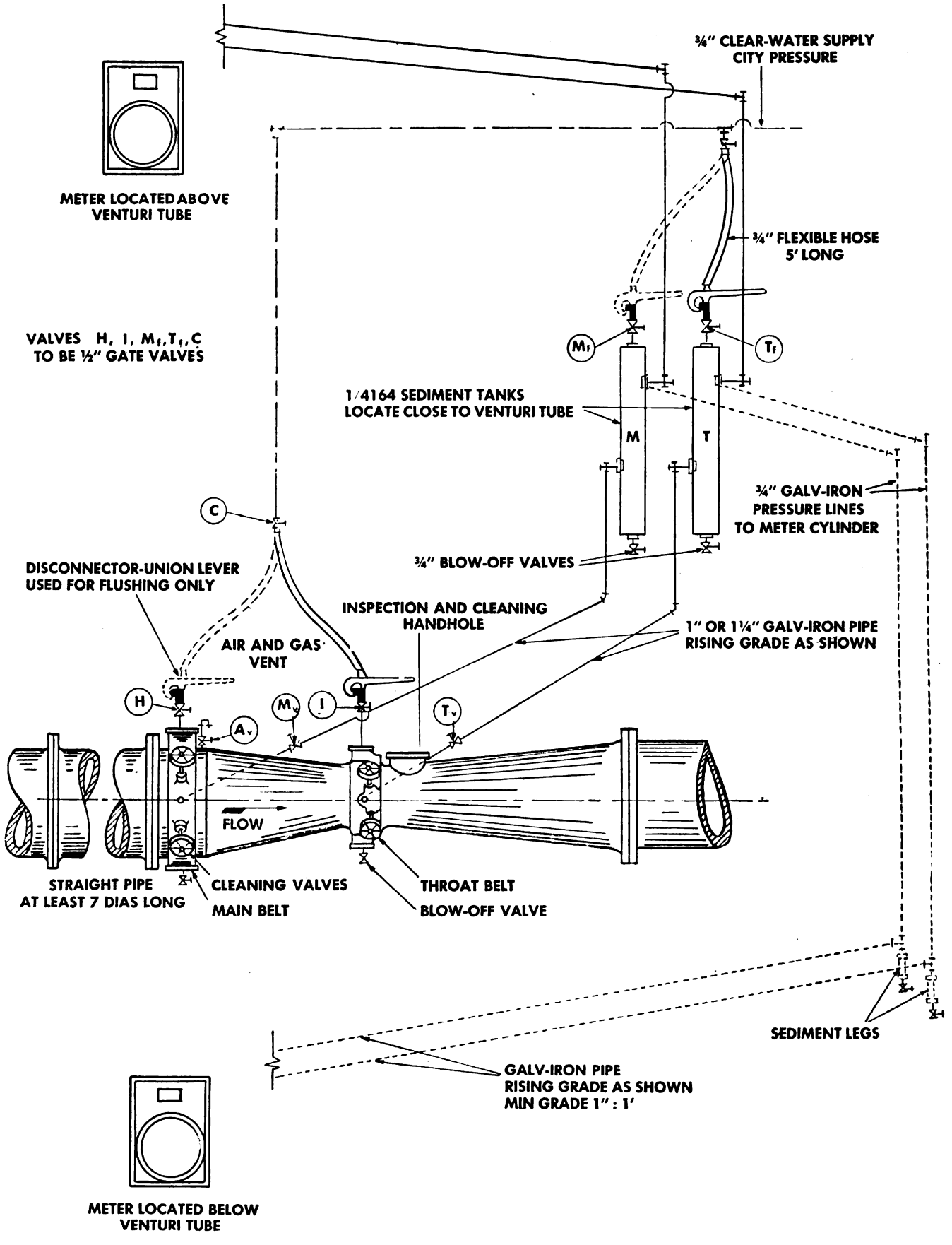


Figure 62. Simplex type-S meter installation.

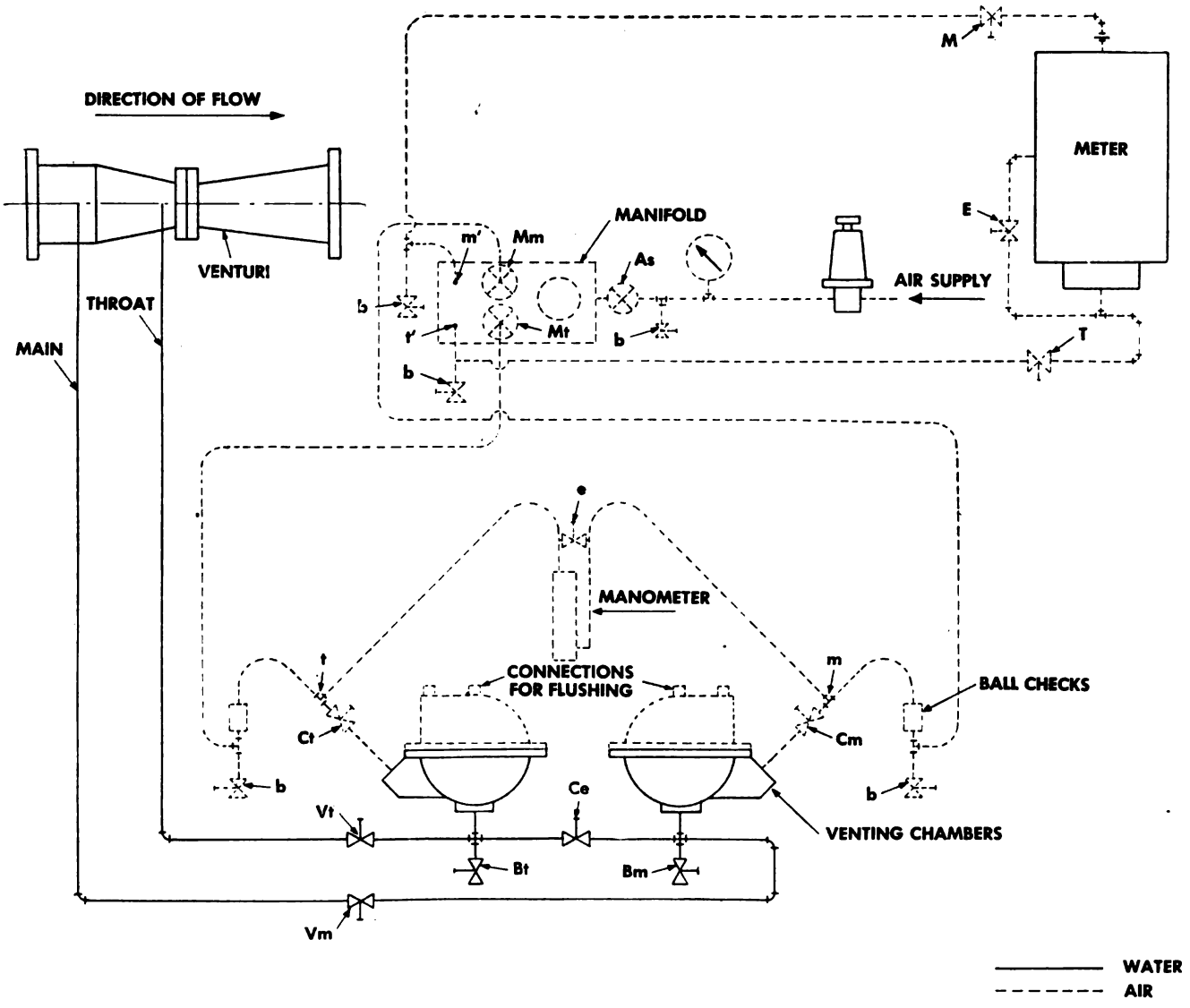


Figure 63. Piping diagram for air-operated venturi meters.

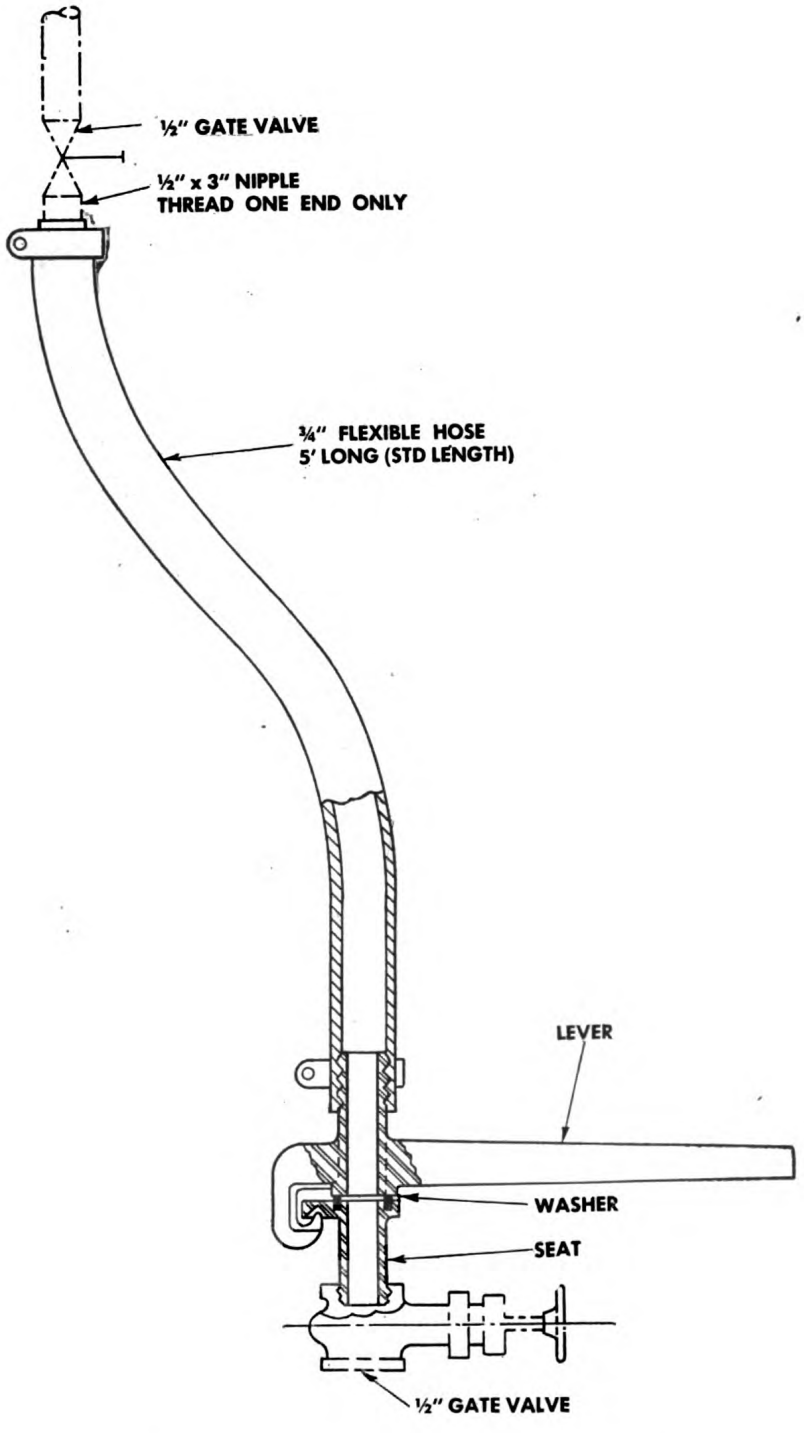


Figure 64. Simplex disconnector assembly.

SECTION XX

CHLORINATING EQUIPMENT

D	W	M	Q	S	A	
						96. General
1						*a.* INSPECT FOR LEAKS. Inspect chlorinator and all piping for chlorine or water leaks. To locate chlorine leak, hold mouth of ammonia-water bottle, preferably of aspirator type, near all joints, valves, and along piping. White fumes of ammonium chloride indicate a leak. Take necessary action to correct leaks immediately, since chlorine leaks increase rapidly in size, resulting in corrosion and destruction of equipment. Keep ammonia bottle tightly stoppered when not in use to prevent loss of strength. Use litharge and glycerin cement in making metal screwed-pipe connections.
2						*b.* OPERATE CHLORINE VALVES. Open and close chlorine valves to prevent threads on valve stem from becoming set in one position. Do not use force in closing a valve.
	3					*c.* CHECK WATER SYSTEM. Clean water strainers and check pressure-reducing valve for proper operation. See that float valves properly control water levels with a minimum of leakage and splashing. Make sure there is not too much water flowing to waste and water levels are at proper elevations. If ejectors do not have their original capacities, remove and clean them.
	4					*d.* CHECK GAS SYSTEM. Check operation of all parts carrying chlorine gas. See that metering devices, pressure-reducing and shutoff valves, and tubing are functioning properly. Disassemble and clean where necessary, determining cause of any fault.
	5					*e.* CLEAN CABINET AND WORKING PARTS. Thoroughly clean chlorinator cabinet, glass parts, floats, metering devices, and other parts on which accumulation of foreign matter would interfere with operations or cause equipment to appear unsightly. Spread a film of petrolatum or similar protective compound on unpainted metal subject to corrosion.
			6			*f.* DISASSEMBLE OR OPERATE HARD-RUBBER THREADS, VALVES, AND PARTS. Hard-rubber threads or parts on a chlorinator freeze or stick when not loosened for long periods. To prevent freezing loosen threads wherever operation of parts may be required to keep chlorinator in service. Before reassembling threads or parts, cover them with graphite grease GH. ***Caution:*** Do not use any tool except a strap wrench on hard-rubber parts; use strap wrench only when necessary, and then with extreme care. Tighten hard-rubber parts only fingertight.
					7	*g.* OVERHAUL EQUIPMENT. Disassemble chlorinator and clean parts. Paint chlorinator cabinet inside and out with three coats of rust-resisting paint. Carefully examine each chlorinator part. Reassemble and check for proper operation.

Abbreviations: D, means daily; W, weekly; M, monthly; Q, quarterly; S, semiannually; A, annually.

(1) *Cleaning.* If it is necessary to clean chlorine lines with liquid, use only wood alcohol or carbon tetrachloride, and allow liquid to evaporate until line is dry. Water combines with chlorine gas to form a highly corrosive acid. Ethyl alcohol and ether combine with chlorine to form a solid waxy substance.

(2) *Lubrication.* Do not use oil or grease on parts coming into contact with chlorine, because they react to form a voluminous frothy substance. Lubricate pipe threads with graphite grease GH.

(3) *Atmospheric condensation.* Condensation may cause scales and other equipment near the cylinder to corrode. Guard constantly against damage from moisture by improving ventilation around cylinder to keep surfaces dry. An electric fan usually is satisfactory. Do not apply direct heat to dry the cylinder.

(4) *Heating cylinders.* Do not try to increase rate of gas withdrawal by heating chlorine cylinders or containers above normal room temperature. Inspect regularly to see that chlorine cylinders are not near steam or hot-water lines or other sources of heat, which may cause serious accidents.

(5) *Cylinder valve gaskets.* When empty chlorine cylinders are replaced by full ones, use a new lead gasket each time in connecting valve or tube end. Use only one lead gasket.

SECTION XXI

SEWER SYSTEMS

D	W	M	Q	S	A	
						97. General
						Unless the sewer system can remove sewage wastes from barracks, latrines, and mess halls without interruption a serious health hazard results. Many difficulties in sewage treatment are caused by poor sewer conditions such as excessive infiltration, grit from broken sewers, septic sewage due to partial clogging by too much grease in sewage, and root growths and other deposits in sewers. The public investment, the safeguarding of health, and prevention of stream pollution make necessary a program of routine sewer inspections, flushing, cleaning, and immediate location and repair of broken sections. The common practice of cleaning and repairing sewers only when serious obstructions are encountered is never satisfactory and is more costly than routine maintenance.
						98. Sanitary Sewers
					6	*a.* MAKE GENERAL INSPECTION. Inspect entire system and prepare schedule of repairs on basis of findings. Check for the following:
						(1) *Gasoline or oil in sewers.* Examine manholes for odor of gasoline or presence of oil slick on sewage surface. If signs of gasoline or oil are found, work back to head of system, inspecting each manhole until source of contamination is found.
						(2) *Obnoxious or explosive gases or vapors.* Use explosimeter where necessary.
						(3) Sand, mud, grit, or detritus, indicating broken or loose sewer joints or sewer pipe.
						(4) Sluggish flow, septic sewage, or accumulation of sewage solids, indicating obstructions, adverse grades, or need for periodic flushing.
						(5) Excessively diluted flow in sanitary sewers, indicating groundwater infiltration or storm-water, roof, or clear-water connections. This is important only where sewage-treatment plant is hydraulically overloaded.
						(6) Manhole masonry in bad repair, particularly above frost line; incorrect grade of manhole cover and top; unsound manhole steps, wooden or concrete covers, and frame mounting on masonry; and improperly seating covers. Raise grade of cover if necessary to stop excessive surface water or earth from entering sewer system.
						Note. Increase frequency of inspection if annual inspection reveals explosion hazards, stoppage of flow, or damage caused by heavy traffic.
					*	*b.* MAKE SPECIAL STORM INSPECTION. Inspect sanitary sewerage during severe storms to find points of excessive infiltration by tracing flow progressively upstream through the system.
	1					*c.* INSPECT OUTSIDE GREASE TRAPS. Check for proper removal of grease

Abbreviations: D, means daily; W, weekly; M, monthly; Q, quarterly; S, semiannually; A, annually.

W	M	Q	S	A	
					and effective cleaning of trap, including removal of sand, grit, or organic material from basin bottoms. Note whether inlet or outlet piping is clogged. See that surroundings are clean and free from odor. Check tightness and soundness of covers and make repairs needed to eliminate hazards.
2					*d.* INPECT OIL OR GASOLINE INTERCEPTORS OR SEPARATORS. Check traps at motor-repair shops, filling stations, and hangers for proper removal of oil, gasoline, and grit. Make sure covers are tight and sound; repair if necessary to eliminate hazards.
				8	*e.* FLUSH AND CHECK SYSTEM. Divide sewer system into three approximately equal sections and clean a different section each year. Give flushing crew the appropriate section of sewer map to insure complete coverage of system. Use rapid rubber ball, sewer hoe, or scooter method to flush out grit and loose organic matter and to indicate other obstructions. Where grease coatings, roots or abnormal obstructions are encountered, clean with flexible rod and cutter, or turbine- or cable-driven cutters and brushes if needed. See TM 5–665 for instructions on sewer cleaning methods and equipment. The recommended three year frequency may be extended to five years where little or no sewer deposits are experienced, such as at posts with steep sewer grades.
	3				*f.* CHECK UPPER ENDS AND FLAT GRADES. Make sure flow is not too sluggish and solids are not accumulating in upper ends and flat grades.
		4			*g.* CLEAN UPPER ENDS AND FLAT GRADES. Remove accumulated solids to increase rate of flow. Clean more frequently if inspection (*f* above) shows need. Flushing by rubber-ball method or self-propelled turbine nozzle may be adequate. If discarded fire hose is used for flushing, paint it an identifying color to prevent its use for emergency potable-water connections. Flushing by fire hose only is ineffective except for 6-inch house laterals, since high velocities cannot be maintained far enough down the sewer. Adequate flushing requires scouring velocities at point where solids are deposited.
		5			*h.* CLEAN INVERTED SIPONS OR DEPRESSED SEWERS. Use beachball method. (See fig. 65.) Clean more frequently if solid deposits build up rapidly.
				7	*i.* CLEAN BUILDING SEWERS AT MESS HALLS. Use rapid method discussed in *e* above.
				9	*j.* FLUSH HOUSE SEWERS FROM LAVATORIES. On posts reasonably free from trouble with house sewers, answering only trouble calls may be more economical.

99. Storm Sewers

				6	*a.* MAKE GENERAL INSPECTION. See paragraph 98*a*.
				*	*b.* MAKE SPECIAL STORM INSPECTION. During or immediately after severe storms, inspect storm-sewer inlets and catch basins for adequacy of water collection and presence of accumulated debris. Clean if necessary.
2					*c.* INSPECT OIL OR GASOLINE INTERCEPTORS OR SEPARATORS. See paragraph 98*d*.
				8	*d.* FLUSH AND CHECK SYSTEM. See paragraph 98*e*.
	3				*e.* CHECK UPPER ENDS AND FLAT GRADES. See paragraph 98*f*.
		10			*f.* INSPECT CATCH BASINS. Inspect catch basins and clean when necessary. Add oil to water in catch basins as necessary to prevent mosquito breeding. Check for fractured inlet gratings.
		11			*g.* INSPECT INLETS. Check for fractures or damage to connecting sewer caused by frost or superimposed loads.

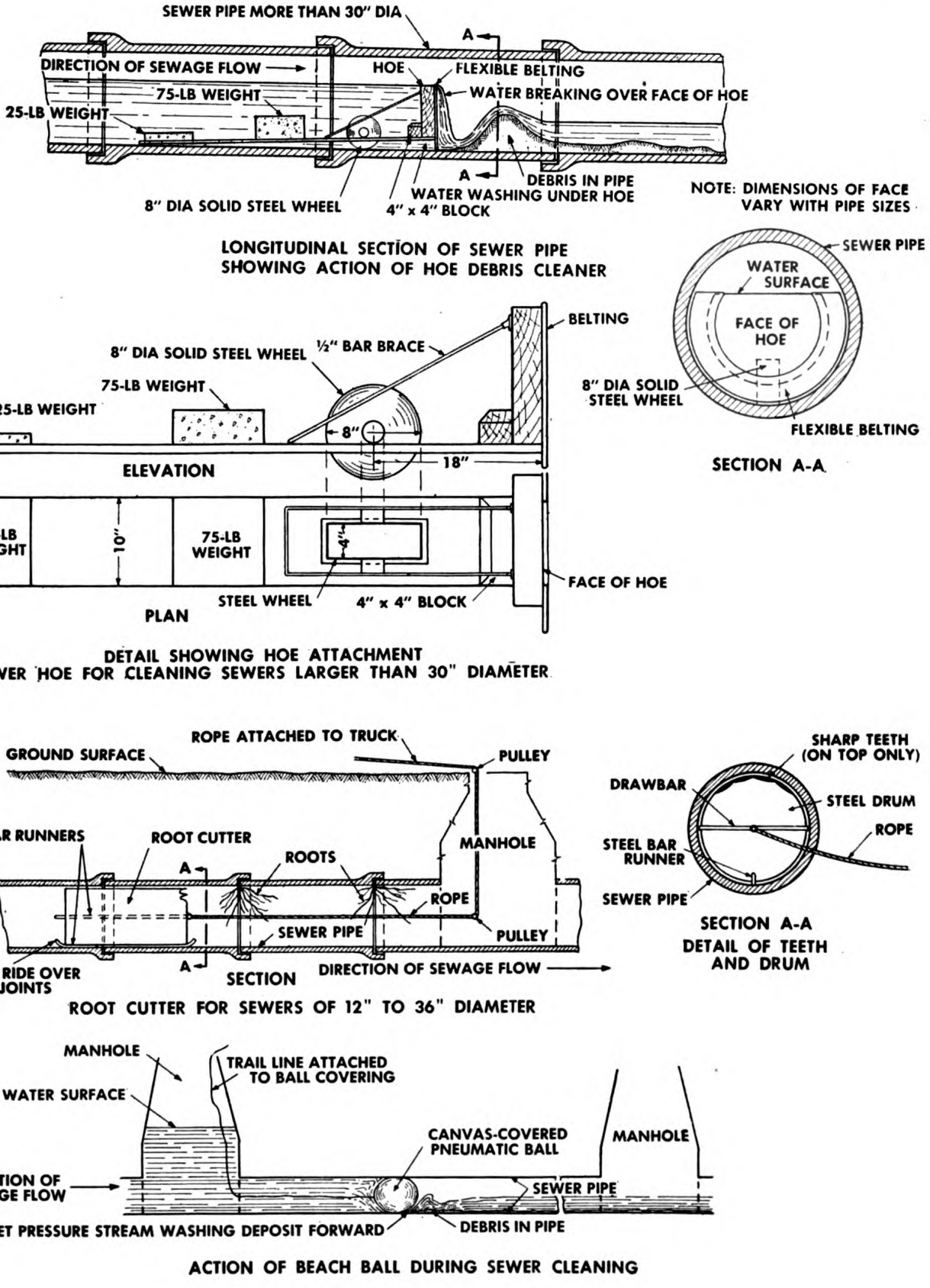


Figure 65. Sewer-cleaning tools.

100. Records of Preventive Maintenance

Use the general sewer-utility map to keep records of all work done on the sewer system. Post entries monthly. To show sections which have been cleaned, draw a colored line on the map parallel to the sewer line. Use a different color crayon each year. Enter more-frequent cleaning jobs and work done in response to complaints by putting a circled number between appropriate manholes. This latter record reveals points requiring abnormal service; such points should be investigated and the faults corrected if possible.

SECTION XXII

COMMAND AND TECHNICAL INSPECTIONS

101. Command Inspections

a. GENERAL. Command inspections are a function of commanding officers, made to determine the general condition of the sewerage works and efficiency of personnel. They may be formal or informal inspections or spot checks. Commanding officers should make these inspections often enough to familiarize themselves with the capabilities of the equipment, adequacy of maintenance and operation policy, extent to which the policy is being followed, and adequacy of personnel training. Since command inspections are neither technical nor routine, they do not take the place of preventive maintenance services or technical inspections. However, they should be thorough enough to reveal major faults, neglect, and carelessness. They should enable the inspecting officer to fix responsibility for defects and to note outstanding performances deserving of awards of merit.

b. PROCEDURE. (1) Command inspections of sewage lift stations and treatment plants should cover the following:

(*a*) Cleanliness of equipment and evidence of excessive wear, corrosion, or unusual noise or vibration during operation.

(*b*) Cleanliness and condition of masonry in pits, channels, and tanks. Presence of unsightly conditions and excessive odor.

(*c*) Completeness, convenience of location, and orderliness of tools and laboratory equipment.

(*d*) Neatness of buildings, grounds, sludge beds, and lagoons.

(*e*) Condition of plant effluent and effect of effluent on stream above and below outfall.

(*f*) Completeness of operating reports and maintenance records.

(2) Command inspections of the sewer system consist of spot checks of a few manholes selected at random, and should include inspecting for sluggish flow, accumulations of solids, odors, maintenance of masonry, and proper cover grade.

102. Technical Inspections

a. PURPOSE. Technical inspections are a function of the post engineer. They are made to determine the physical condition of system and plant, effectiveness of the preventive maintenance program, and need for additional training of operating and maintenance personnel. These inspections are performed by technically qualified officer or civilian personnel.

b. SCOPE. Technical inspections are made of all major functional structures and items of equipment or portions of the sewer system selected at random. They are normally made without prior notice, except when maintenance schedules or conditions require disassembly of equipment or draining of tanks. Technical inspections include:

(1) Checking WD AGO Form 5–34, for completion of scheduled inspections and preventive maintenance services.

(2) Determining whether all higher echelon maintenance noted on the record card as being required has been completed.

(3) Noting frequency of higher echelon maintenance or repair.

(4) Inspecting individual units, using scheduled inspection items on the card and in this manual as a guide.

(5) Where higher echelon maintenance or repair requirements have been abnormal, checking loading and operating conditions carefully, and giving consideration to possible need for revision of maintenance service and inspection schedules to fit local conditions.

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